THE GLASS INDUSTRY

VOLUME 19, NUMBER 6, JUNE, 1938

GRADING AND RECLAIMING GRINDING SAND

By F. G. SCHWALBE

Toledo Engineering Co.

At its River Rouge glass plant Ford Motor Co. regrades and classifies levigated grinding sand with unusual equipment and utilizes modern methods for reclamation of materials and heat.

The Ford Motor Company grinds a total of about 250,000 square feet of plate glass surface every 24 hours. The details of the grinding operation were fully described in the January, 1938, issue of THE GLASS INDUSTRY. It is now possible to show how the grinding sand is continuously graded and classified by grain size until it is worn to a powder and how the disposal of the refuse is handled to prevent losses of usable materials or heat.

In this system it has been found by experience that the proportion of sand to water by volume should be roughly 25 per cent and it is important that the proportion of sand and water remain as constant as possible. New sand and other materials, such as glass ground from the surface of the plate, are continually being added to the system. These other materials must, therefore, be continually removed, so that the correct density and viscosity of the sand and water mixture are maintained.

The Ford grinding line is illustrated in Fig. 1 and it will be recalled that the line consists of two parallel rows of grinding heads, with 30 heads in each row. The row shown in Fig. 1 grinds one face of the rough glass sheet, the parallel row grinding the second face after the first face has been polished and the sheet turned over on the table. Each face of the sheet enters its grinding line in the rough state as it comes from the rolling machine, but when it leaves the grinders the surface has only minute indentations from 0.000008 to 0.000009 inches in depth.

For most rapid grinding and best final finish on the ground surface it is apparent that coarse sand should be used on the first heads in the line and that the grain size used by the following heads should be continuously decreased until the finest sand is utilized in the last head, thus leaving the smoothest possible surface. The sand is reduced in grain size by crushing or attrition each time it passes under a grinding head and, while it is then too small to be used again in that particular head, it can be utilized at the later positions until it reaches powder form and has no further usefulness for grinding.

All of the sand coming from the grinders is, therefore, regraded and classified by means of a most ingenious and unusual continuous process in which the mixture of sand and water, at constant temperature, is flowed over sedimentation cones at practically constant velocities. The larger grains are deposited in the first cones, the smaller grains being dropped at the later stations. The powdered material passes on to a Dorr thickener and filter where the heated water is removed from the sludge. The first six grinding heads receive the coarsest sand and the grain size used in the remaining 24 heads decreases from 40 mesh (1/64 in. diameter) down to 700 mesh (0.0006 in. diameter).

The amount of raw sand required by the Ford grinding

Fig. 1. View looking down the first grinding line, in which the small pipe carrying grinding sand and water to the center of the cast-iron grinding lap may be seen.

Fig. 2. Elevator and belt conveyors which deliver raw sand to the storage bins. The triangular plows for unloading the belts are on the framework above the belts.

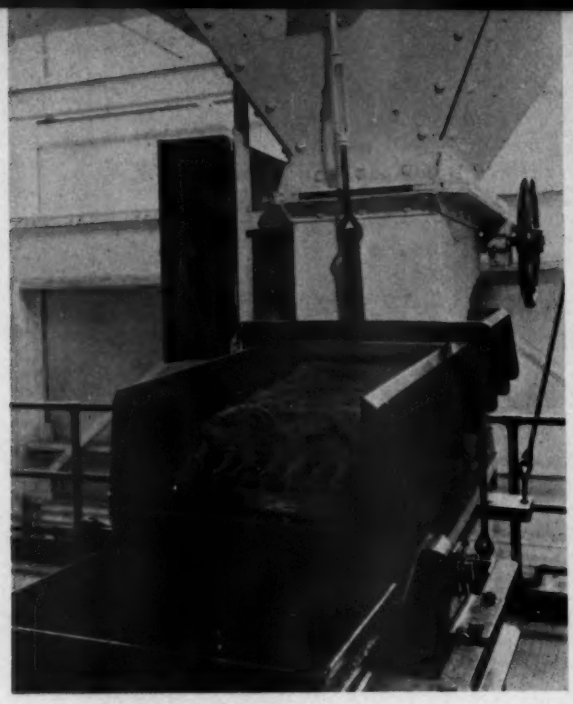


Fig. 3. This vibrating feeder delivers raw sand from the storage bins to the vibrating screens.

Fig. 4. Vibrating screens for raw sand. Piping discharges water at 125 lb. pressure to carry the sand along.

lines varies from 3½ to 4 pounds per square foot of glass ground, or a total of approximately 220 tons every 24 hours. The sand is Manistee beach sand from Lake Michigan and is brought to Detroit by boat. It has a yellow appearance and the screen analysis is as follows:

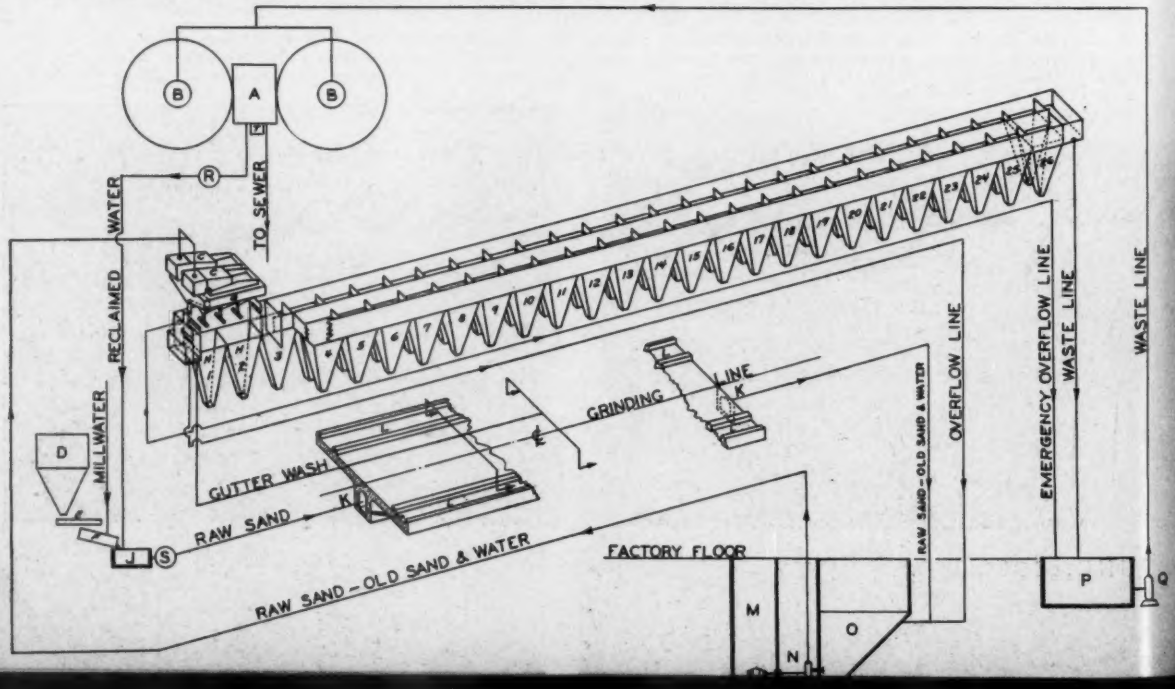
42 mesh	22.1	per cent
60 mesh	50.3	" "
80 mesh	24.1	" "
100 mesh	3.1	" "
Through 100 mesh	.03	" "

Upon arrival at the Ford plant the raw sand is stored outdoors in large piles from which the daily requirement of 220 tons is transported to concrete storage bins in the plant. The sand is delivered to the bins by means of an elevator that discharges upon one of two belt conveyors, the capacity of the bins being about 30 carloads. A movable plow unloads the sand from the belt at the desired bin. Fig. 2 is a view of the top of the sand storage bins showing the elevator and the two belt conveyors.

Raw Sand Processing

From the storage bins the raw sand is transported to one of two 50-ton steel bins, from which it is fed by a vibrating feeder, Fig. 3, in a continuous stream to the vibrating screen illustrated in Fig. 4. Discharging through several nozzles, water at 125 lbs. pressure carries the sand over the vibrating screen and removes foreign matter. Foreign matter from the screen is pumped to the Dorr thickener unit for disposal. The screen has openings 5-mesh long and 20-mesh wide and discharges into the

Fig. 5. Diagram of sedimentation system and debris disposal. A. Dorr filter house; B. Thickener tanks; C. Vibrating screens; D. Raw sand hopper; E. Vibrating feeder; F. Vibrating screen; G. Screen hopper; H. Rough grader cones; J. Raw sand sump; K. Flume; L. Gutters; M. Pump motor pit; N. Circulating pump; O. Main sump; P. Dorr thickener sump; O. Waste pump; R. Reclaimed water pump; S. Raw sand pump; T. Debris discharge.



raw sand sump J, Fig. 5. A float valve in the sump controls the operation of a pump which discharges excess water to the Dorr thickener to prevent flooding.

A rubber-lined pump S, Fig. 5, with a capacity of 300 gallons per minute and driven by a 15-h.p. motor, is controlled by an automatic electrically-operated float valve and takes the raw sand and water from the sump, discharging it to the flume K located below and between the two grinding lines. This flume becomes the source of all the raw sand added to the grinding system.

Pumps and Sumps

As shown in Fig. 5, the raw sand, together with water and used sand from the grinding lines, is discharged from the flume into the main sump O, this sump being 16 ft. wide, 20 ft. long and 16 ft. deep. Near the bottom of this sump, which is 35½ feet below the factory floor level, are the inlets to two large circulating pumps N, one of which is used in normal operation with the second acting as a standby. Each pump has a capacity of from 2,000 to 4,000 gallons of sand and water per minute and is driven by a 250-h.p., 750-r.p.m., direct-current motor. These direct-current motors permit very accurate control of the pump discharge and are located in a water-tight pit M adjacent to the pumps. The motors drive through flexible couplings, the driving shafts passing through stuffing boxes in the 18-in. concrete wall between the motors and the pumps. Electric control for the motors is mounted on the factory floor. Automatic sump pumps prevent flooding of the motor and pump pits, each pump having a capacity of 200 gallons per minute. All pumps are rubber lined to resist the cutting action of the sand.

The mixture of sand and water leaving the 250-h.p. circulating pump is elevated approximately 100 feet to a vibrating screen C located above the rough grader tank and shown in Fig. 6. The least radius of all bends in the 10-in., rubber pipe carrying the sand mixture to the screens is 8½ feet, and velocities in all pipes are maintained in the range of 6 to 14 ft. per second. Above this range the cutting action of the sand is excessive, and below this range the carrying capacity of the water is not sufficient to keep the sand in suspension.

Vibrating Screens and Hoppers

The vibrating screens C are 5 ft. wide by 14 ft. long, with a 5-mesh length and a 20-mesh width, and are similar in design but larger than those shown in Fig. 4. These screens remove bits of broken glass, plaster, and such other debris as may find its way into the sand mixture from the grinding line. The screened mixture goes from the screens into a 12 x 18 ft. hopper G, the bottom of which is provided with three cones discharging the sand and water through 10-in. pipes into the rough grader tank. To insure a constant discharge from each of the hopper cones, an orifice with an opening determined by experiment is attached to the end of each discharge pipe. A constant pressure head must be maintained to provide a uniform discharge from these orifices and this is accomplished by providing an overflow.

Sedimentation Cones

The heavier sand particles in the mixture discharging into the rough grader tank settle out almost immediately and drop to the bottom of the cones. Here it is again essential that a constant head be maintained to insure constant discharge from the top of the rough grader tank to the other tanks in the sedimentation system proper. An overflow weir is provided for this purpose and its discharge, together with the overflow from the screen hopper, empties into a compartment at the end of the rough grader tanks. The water and sand from this compartment are carried away through two 8-in., rubber-lined pipes and discharged into the gutters at each side of the grinding lines. This mixture, under a pressure head, aids to carry the water and sand entering the gutters from the grinding tables along to the main sump.

The constant pressure head on the gutter wash lines is maintained by an overflow weir in the compartment feeding these lines, the overflow being carried to the main sump through a 6-in. rubber-lined pipe. As an added protection against possible flooding of the rough grader tank, an emergency line is also provided and discharges into the supply pit for the Dorr thickener.

The sand and water mixture from the rough grader tanks now enters the sedimentation tanks. These tanks have an overall length of about 240 feet and each is divided into 24 units, thus providing a separate unit for each of the last 24 heads in each grinding line. The bottom of each unit is cone-shaped. Each unit has a width of about six feet and a length of 10 feet. The depth from the tank top to the cone bottom is 26 feet. Combined capacity of the sedimentation system is 280,000 gallons of water and solids.

Fig. 6. Top of rough grader tanks showing discharge into No. 3 sedimentation tank.

Fig. 7. Vibrating screen installation above the rough grader tanks.

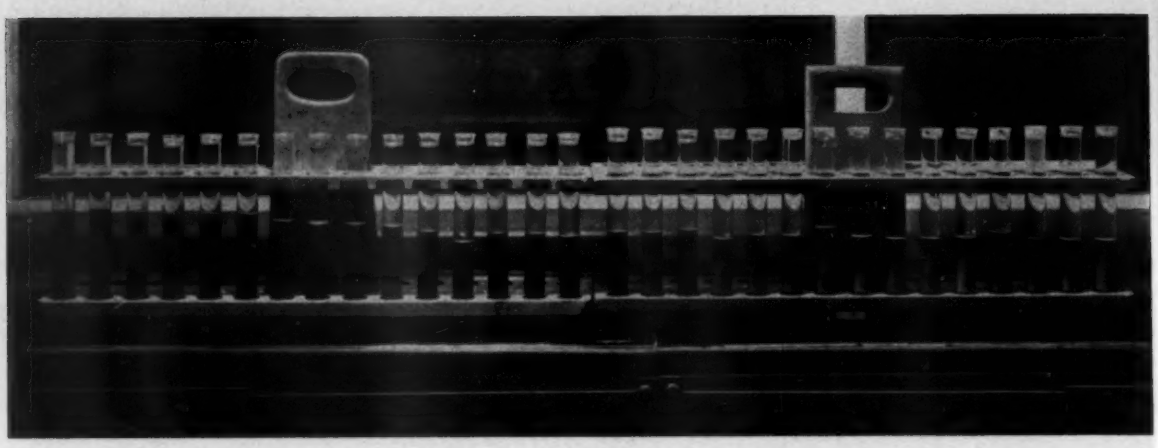


Fig. 8. Settled samples of grinding sand and water taken from the various sedimentation cones.

The greater part of the sand and water lies dormant in each tank, flow taking place to a depth of 12 to 24 inches only. The weir at the extreme end of the tanks is submerged about one inch during normal operation and at this point a check is made hourly to ascertain the rate of flow through the system. Fig. 6 is a view at the top of the sedimentation system showing the discharge from No. 2 into No. 3 tank.

During the flow of the sand and water mixture in the system sedimentation of the solids takes place, the heavier particles falling first. The solids carried over the weir by the water leaving the system are so fine as to be of no value in the grinding process.

Sand and water from the first rough grader cone feeds the first three grinding heads and the second rough grader cone feeds the next three heads. All of the other 24 grinding heads are supplied with sand and water mixture from separate cones. Samples of water and sand mixtures taken hourly from three cones are checked for density by weighing the samples. The front cover illustration shows the bottom of the cones. The following values are averages taken at three points in the system:

Location	Density	Grain Size	Mesh
Sedimentation cone 13	1.23 to 1.25	.0016 to .0018	325
Sedimentation cone 20	1.22 to 1.24	.001 to .0012	450
Sedimentation cone 26	1.14 to 1.18	.0006 to .0008	700

The quantity of sand and water discharged from the first six cones is approximately 58 gallons per minute per cone and the discharge per cone decreases successively to 5 gallons per minute on the last cone. The discharge from each cone is arranged, of course, so that the rate of flow in the unit is proper for the deposition of the required grain size in that cone.

Water Temperature

The mixture of sand and water in the sedimentation system is maintained at a constant temperature of 90° F. by introducing approximately 83 lbs. of steam per minute into the sand and water mixture in the main sump. This constant temperature is necessary to insure constant viscosity of the water. For each increase of one degree Fahrenheit in the water temperature the sand carrying capacity is decreased by approximately one per cent in the grain size.

pH Hydrogen Potential Check

At a point midway in the system a hydrogen potential meter is located in the flowing stream of sand and water in the top of the sedimentation tanks. The tendency of the mixture is to be alkaline on account of the lime introduced from the glass bedding plaster and, after continued operation, the alkalinity builds up. An increase in the pH of the liquid increases its carrying capacity, so the pH must be controlled. This is done by the addi-

Fig. 9. Microscopic photograph of 400-mesh sand grains separated from a sample by means of the elutriator.

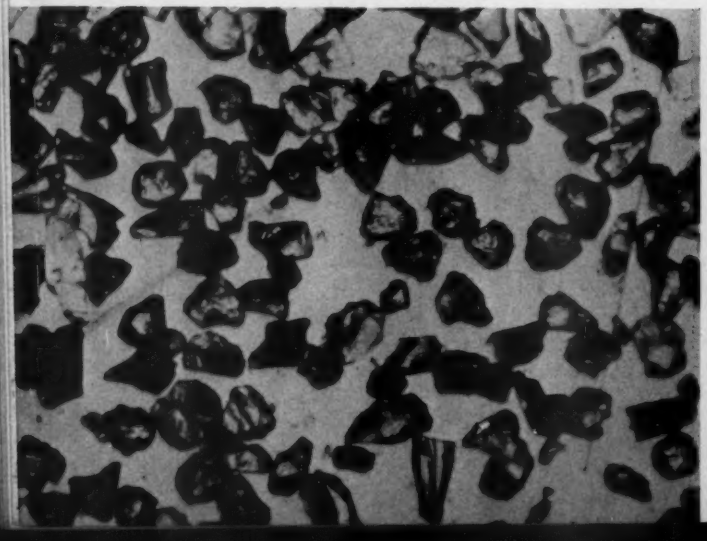


Fig. 10. Elutriators used to find the grain size of the sediment in each sample of sand and water mixture.

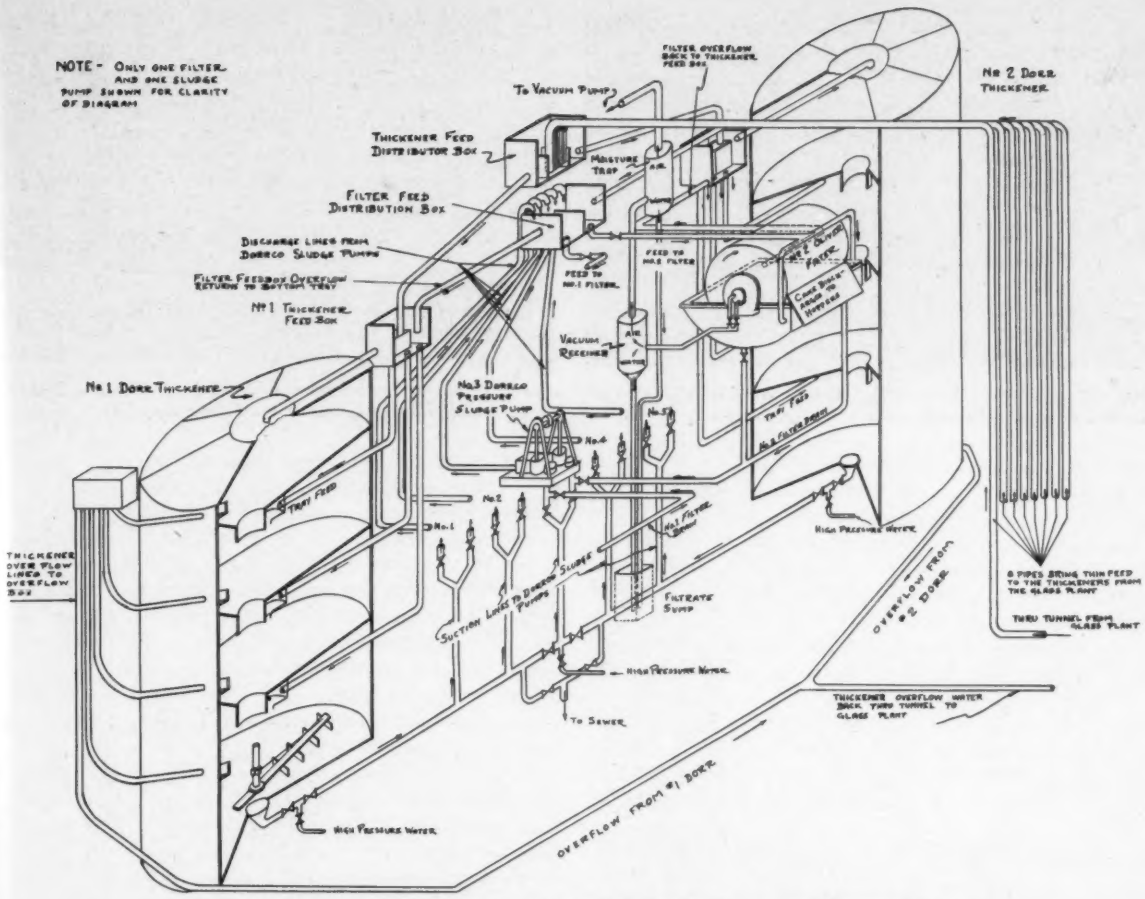

NOTE - ONLY ONE FILTER AND ONE SLUDGE PUMP SHOWN FOR CLARITY OF DIAGRAM
FILTER OVERFLOW BACK TO THICKENER FEED BOX
No 2 DORR THICKENER
To VACUUM PUMP
THICKENER FEED DISTRIBUTOR BOX
MOISTURE TRAP
FILTER FEED DISTRIBUTION BOX
DISCHARGE LINES FROM DORRCO SLUDGE PUMPS
FILTER FEEDBOX OVERFLOW RETURNS TO BOTTOM TENT
No 1 THICKENER FEED BOX
No 1 DORR THICKENER
VACUUM RECEIVER
No3 DORRCO PRESSURE SLUDGE PUMP
No4
No5
No2
No1
TRAY FEED
THICKENER OVER FLOW LINES TO OVERFLOW BOX
SUCTION LINES TO DORRCO SLUDGE PUMPS
FILTRATE SUMP
HIGH PRESSURE WATER
To SEWER
OVERFLOW FROM #2 DORR
8 PIPES BRING THIN FEED TO THE THICKENERS FROM THE GLASS PLANT
THRU TUNNEL FROM GLASS PLANT
THICKENER OVERFLOW WATER BACK THRU TUNNEL TO GLASS PLANT
OVERFLOW FROM #1 DORR

Fig. 11. Diagrammatic layout of the debris disposal and water reclamation plant.

tion of sulphuric acid in sufficient quantities to maintain the pH at 8.4. This makes the water slightly alkaline, pH 7.0 being neutral.

Laboratory Check and Control

The Ford sedimentation system is always under the watchful eye of the laboratory and the operating staff. As previously stated, quick test samples are taken every hour at three points and the density of the mixture is checked by weighing the sample. Referring to the tabulation of densities and grain sizes it will be noted that there is a definite relationship between the two.

A complete check is made periodically on each cone in the system by taking a test-tube sample from each cone. Each sample is marked and placed in a rack where it is allowed to remain until all of the solids have been settled. This usually takes about four hours. When the liquid in the sample is clear the depth of the sediment in the tube is compared to the depth of the entire sample, thus giving a rapid and accurate calculation to determine the density of the sample. Fig. 8 shows settled samples taken from the various cones.

Having determined the density of the mixture, the next step is to find the grain size of the sediment in each sample. This is done by weighing the sample and running a screen test on all solids down to 325 mesh, the remainder of the sample being checked for grain size by means of an elutriator.

Elutriator Test

The operation of the elutriator is based on the fact that a particle will just be suspended in a rising current of water if the velocity of that current is equal to that which the particle itself would attain when falling in still water. Fig. 9 shows elutriators for determining grain size, the device consisting of a glass tube, open at the top, provided with an overflow, and with a regulating cock at the bottom. The tube has a diameter of two inches and a length of about 36 inches. An overhead tank supplies water at constant pressure and temperature for circulation through the instrument. The velocity of water in the tube is adjusted so that all particles finer than a given size are carried upward to the overflow, while the larger particles either sink or stay suspended.

The flow of water through the elutriator is checked by measuring the time required to collect a given sample from the overflow outlet. Based on experimental data and calculations, figures have been established for the necessary rate of flow to carry sand grains of a given size in suspension. For checking a sample to determine how much of it is, say, 350 mesh and finer, the procedure is as follows:

The sample of wet sand is first weighed. The flow of water through the elutriator tube is then fixed at a rate that will maintain in suspension all grains of 350 mesh and finer and the weighed sample is dumped into the top of the elutriator tube. The water in the device is then

Fig. 12. View of Dorr filter units, showing the fabric-coated drums which remove the sludge from the water.

Fig. 13. Dorr filter house and thickener tanks. Notice debris being discharged into truck for disposal.

permitted to flow until all of the 350-mesh and smaller grains are removed from the sample. When the water leaving the elutriator overflow pipe is clear the test is completed. The sand remaining in the bottom of the tube is removed and weighed and the loss of weight in the sample is the amount of 350-mesh and smaller material in the original sample.

As mentioned before, grain sizes down to 325-mesh may be screen tested and the elutriator makes it possible to test, by varying the rate of flow in the tube, any grain size in the sample from 325 to 700 mesh. Fig. 9 shows a microscopic photograph of 400-mesh sand grains which were separated from a sample by means of the elutriator. The uniformity of the grain size and the presence of smaller particles may be noted. These smaller particles remained in the sample due to agglomeration with others.

Disposal and Reclamation Plant

An exterior view of the debris disposal plant is shown in Fig. 13, the Ford installation being the only one of its kind used for this particular purpose in the glass industry. In the usual grinding line installations the waste water and debris are pumped into large outdoor settling ponds formed by earth embankments. This practice requires a great deal of ground area and results in a total loss of the water and the heat. As they become filled, debris from such ponds must be removed to other points for permanent disposal and the ponds are also a nuisance when dried out, since the fine debris is blown about.

The approximate amount of debris collected from the Ford grinding and polishing lines each 24 hours is made up of the following items:

Sand	220 tons
Ground glass	48 tons
Iron from the grinding laps	4 tons
Plaster	20 tons
Rouge	2 tons
Accompanying water	29 tons
Total	323 tons

Ninety per cent of the water accompanying the debris is reclaimed with a drop of only 10 degrees from the initial temperature. This represents an enormous saving in water and steam, since 4,000 gallons of water are saved per minute and the saving in fuel amounts to approximately 40 tons of coal every 24 hours.

Illustrations courtesy of Ford Motor Company.

The operation of the Dorr thickener and filter unit is shown diagrammatically in Fig. 11. Waste water and debris are pumped to the thickener feed distributor box and from this feed box the mixture is fed to one or both of the Dorr thickener units. These units consist of insulated steel tanks 600 feet in diameter and 30 feet high, each tank being provided with four trays or settling basins. The mixture of water and debris is discharged into the trays and most of the solids settle out at this point.

Each tray is provided with a slowly revolving scraper which carries the settled solids to the center of the trays, from which point the sludge drops to the bottom of the tank and is withdrawn by reciprocating sludge pumps. The sludge contains from 30 to 50 per cent of solids and is pumped to the filter tanks illustrated in Fig. 12. In these filter tanks the lower face of a horizontal, continuously-revolving, filter drum is submerged in the sludge, the outer face of the drum being covered with fabric and the inside of the fabric being subjected to a vacuum of eight inches of mercury. The action of the vacuum causes the sludge to build up against the fabric to a thickness of about half an inch, the water from the sludge being drawn through the fabric and discharged to the filtrate sump. A scraper blade removes the debris from the drum and discharges it into a storage hopper. Containing about 10 per cent moisture by weight, the debris is finally loaded into trucks and hauled away for disposal.

Reclaimed water leaves the thickener containing 12 grains of solids per gallon and is returned to be used again in the Ford grinding and polishing process.

1939 A. C. S. MEETING

Word has been received from Ross C. Purdy, general secretary, that the 41st annual meeting of the American Ceramic Society will be held at the Hotel Stevens, Chicago, the week of April 16, 1939. This announcement is being made early to avoid any conflicting schedules.

SOCIETY OF GLASS TECHNOLOGY MEETS

The annual general meeting of the Society of Glass Technology was held in Sheffield, England, April 13, 1938. The election of officers resulted in C. J. Peddle becoming president, succeeding Professor W. E. S. Turner, who was appointed honorary secretary. F. G. Orme was reappointed honorary general treasurer, and Francis C. Flint, honorary American treasurer.

FEEDING BATCH TO TANK FURNACES

By V. C. FUGMAN and H. I. VORMELKER

General Electric Co., Cleveland

The trend towards mechanization which started in the glass industry about twenty-five years ago naturally brought with it many and various designs of mechanical devices for charging batch to tank furnaces, the purpose being to eliminate a rather unpleasant and arduous labor job and also to improve furnace operation and glass quality. Before discussing the particular type of feeder with which this article is mainly concerned, it will be of interest to refer briefly to some of the various feeder designs that have been tried and developed.

The first improvement over hand shoveling from a batch wagon into a doghouse was, of course, the installation of overhead bins with spouts terminating in manually-operated gates over the doghouse, from which batch could be drawn by gravity into the doghouse and pushed into the tank by means of a hoe. The next logical step was a mechanically-operated pusher, designed to replace the man and the hoe. Although the mechanical feeder will not, in many cases, produce a direct reduction of the labor force, it may still be properly classed as a real labor-saving device, because it frees the furnace man from a disagreeable operation and gives him more time for other more important duties.

The mechanical feeder has other distinct advantages. First, a practically continuous rate of feeding adjusted to the rate at which the glass is being worked out of the tank, thus producing a uniform melting condition and also holding a constant level of glass. The glass level is of particular importance with vacuum gathering machines, such as the Westlake, where a change in level as small as one-sixteenth inch is detrimental. Second, less dust around the doghouse, also less dust and fume in the tank to be carried into exhaust flues and checkers, thus helping to keep the regenerator or recuperator operating at maximum efficiency. Third, longer life of refractories around the feeding opening, due to absence of stingout around a properly sealed-in water-cooled feeder barrel.

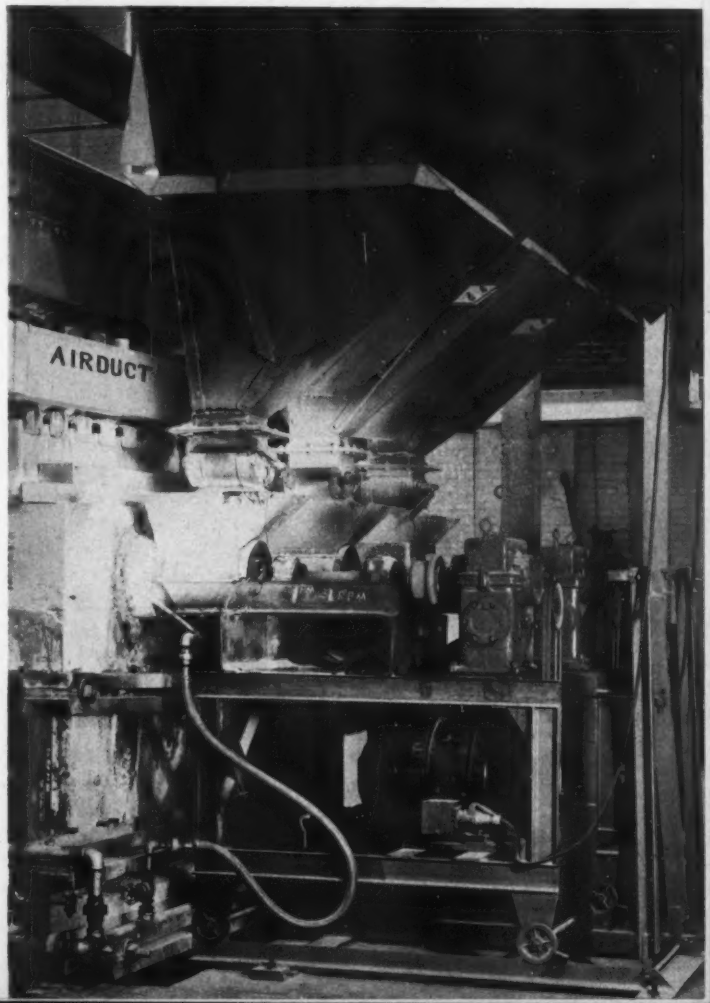
It is safe to say that every known type of mechanical feeder used in other industries has been tried, or at least proposed, for glass tanks. Of the reciprocating, pusher-type feeders, the Hazel-Atlas with an oscillating as well as reciprocating motion has been notably successful. Vibrating feeders are said to be successfully operating at several plants. In a rather daring variation of the pusher-type feeder, designed to eliminate all dusting in the tank, it was proposed to feed the batch through an opening in the back wall below the glass surface. Whether this feeder ever reached the point of practical application we do not know.

The Ford Motor Company has attacked the problem of dust by feeding batch in the form of briquettes. Interesting examples of this same principle are the chewing gum vending machines used to feed glass marbles to the miniature tanks used for making textile fiber glass.

The feeder with which we are most familiar and which we propose to describe is an adaptation of the well-known helical screw conveyor. This design has proved to be a good solution to the problem of feeding batch mechanically and has been in successful operation in the glass plants of the General Electric Company for many years, the Pitney installation being shown in the accompanying illustrations. It has lately been adopted by a large manufacturer of enamel frit for feeding batch to frit furnaces.

One of the important advantages of this feeder lies in the fact that its water-jacketed barrel can be extended entirely through the back wall of the tank proper, or that of an enlarged covered doghouse (more properly designated as a charging bay) which has been found to be a preferable construction. Since the barrel fits closely in the circular opening through which it passes, all stingout and blowing-out of batch dust when some pressure is carried in the tank is prevented and the wear due to fluxing away of refractories around the feeding opening is minimized. The blocks directly under the feeder barrel have curved notches about one and one-half inches deep and conforming to the barrel, so the

Installation of screw-type mechanical batch feeders at Pitney Glass Works, Incandescent Lamp Dept. of General Electric Co., Cleveland. Mixed batch stored in hoppers above the feeders. Note mounting of feeders and drives on wheeled framework to facilitate withdrawal.



Presented at the Fifth Conference on Glass Problems, University of Illinois, May 20-21, 1938.

Closer view of screw-type feeder installation. Screw shaft mounted in dust-proof anti-friction bearings and driven through double-reduction worm-gear speed reducer by a variable-speed motor. Piping for cooling water and the method of sealing feeder barrel into the furnace wall may be noted.

discharge is located practically at the glass level and dusting from a free drop of batch materials is eliminated.

For feeding batch in amounts of, say, fifteen to sixty tons per twenty-four hours, an 8-in. diameter by 8-in. pitch screw operating in a 10-in. barrel has been found suitable. The shaft carrying the screw flights is extended through the closed rear end of the barrel and carried in two heavy, dust-proof anti-friction bearings. It is coupled directly to the slow-speed shaft of a double worm-gear reducer which is driven in turn through V-belts by a variable-speed motor.

Standard commercial materials are used throughout. The screw and the discharge end of the barrel are the only parts which wear out and require occasional replacement under normal usage. The screw flights are made preferably from a hard, abrasion-resistant alloy iron and for maximum life the edges of the forward screw flights can be reinforced with Stellite or Stoodite. The barrel is made of 10-in., extra-heavy steel pipe surrounded by a section of 12-in. pipe to make the water jacket. Two ⅜-in. pipes in the space between the 10-in. and 12-in. pipes carry cooling water to the front end of the jacket, the outlet being a 1½-in. opening at the top of the rear end of the jacket. The front edge of the barrel is also reinforced with Stellite to prolong its life.

Batch material flows continually from the overhead bin into a small inlet hopper mounted over a 6 x 13-in. opening in the rear end of the feeder barrel. The barrel, screw, shaft, bearings and reducer are all carried on a simple structural steel chassis, so arranged that replacement of screw flights, shaft, barrel or other parts can be made readily. The whole assembly is mounted on a four wheeled carriage that moves on an angle-iron track, making it a simple matter to back the feeder from the furnace opening for repairs or when it is desired to stop feeding for any considerable period, such as week-ends. When the feeder is withdrawn the tank opening is closed by means of a refractory plug.

The accompanying illustrations show three feeders in working position and illustrate the general arrangement. It will be noted that the track is hinged to fold up back of the feeder carriage and out of the way. This particular installation is on a tank which is twenty feet in width and is making about 120 tons of glass in 24 hours. The charging bay is 10½ feet wide and the feeders are on 4-foot centers. Each feeder will discharge about fourteen pounds of batch per revolution. Our batch requirements were such that a speed range of from 2 to 8 r.p.m. was provided, that is, from 21 to 84 tons per 24 hours for each feeder. In case of failure of one feeder, the remaining two have sufficient capacity to easily maintain the required charging rate.

By charging at three separate points, the batch is spread thinly over a considerable area, thus providing a more efficient utilization of the melting zone.

The life of the feeder screw and barrel depends largely on the amount of cullet in the batch, and with a batch consisting only of the usual raw materials the wear is negligible. When a large proportion of coarse cullet is present, there naturally is considerable abrasive action. In the installation shown the batch contains 60 per cent of cullet and the forward screw flights are replaced about every thirteen months. The water-jacketed barrel has a life of about eighteen months, depending to some extent on the character of the water used.

Another factor having a marked effect on the life of the screw and barrel is the design of the doghouse, or charging bay. This should be sufficiently wide so that there will be no accumulation of semi-molten batch piled up in front of the feeder. In such cases considerable back pressure builds up against the feeder screw and shortens its life appreciably. This was the case in one of the earlier installations, where feeder screws lasted only six weeks and barrels two to three months.

Power requirements are quite moderate, being only three-quarter horsepower for each of the feeders shown. A liberal estimate of operating cost, allowing for 20 per cent depreciation in addition to replacements of screw and barrel and including cooling water and power, shows an overall cost of less than 2½ cents per ton of batch charged.

SUGGESTS NEW NAME FOR A. C. S.

Royden A. Blunt, vice-president and general manager of the Buck Glass Co., Baltimore, writes THE GLASS INDUSTRY of an incident that occurred while en route to the New Orleans convention. The officers and trustees of the American Ceramic Society have often gone on record as desiring constructive suggestions for the benefit and welfare of the Society, and in that spirit Mr. Blunt's letter is herewith placed on the record:

"Editor, THE GLASS INDUSTRY:

"While proceeding to New Orleans on the Ceramic Special, I wired my brother-in-law, gave him the time of my arrival in New Orleans and expressed the hope we could spend the day together. He was at the station at the appointed time when the regular train came in. When I did not get off he inquired from a station man when the next train would be in from Louisville, as he was expecting a man on the train which had just come in.

"The station man said, 'There ain't no more trains until evening,' and at that very moment my brother-in-law looking down the yard saw our train coming in. He asked the attendant where that train was coming from. He answered, 'Oh, he ain't on that train, that's the *Uremic Special* coming to the Convention!'

Royden A. Blunt."

MOLD DESIGN AND MACHINE OPERATION

By G. B. LANGER
Lynch Corporation

In the time available it is impossible to consider in detail the various types of forming machines and other factors that have considerable bearing on the problems of mold design and operation. But it is also difficult to generalize, because many of us remember instances where similar molds working under what were thought to be similar conditions gave different results. Most glassmen will agree that this branch of our industry has been sadly neglected and that, to maintain efficient production of good-quality ware, there are certain aspects of both mold design and feeder operation which should invariably be considered in definite relation with each other.

It has been suggested many times that mold design be conducted on a scientific basis but, unfortunately, little or nothing has been done in this direction up to the present time. So far as I am aware, there have been no more than on or two attempts to measure the temperatures of molds while in operation.

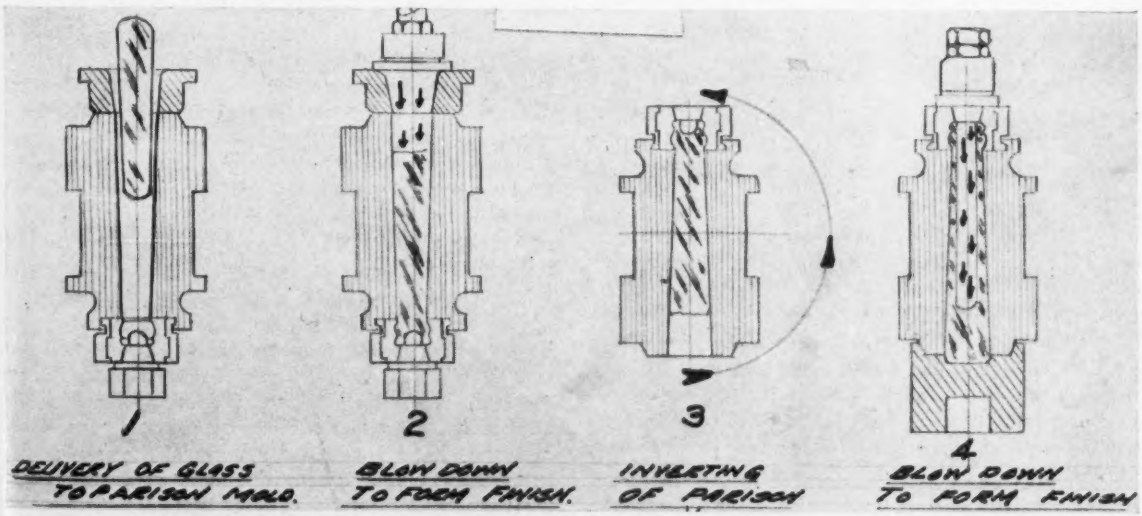
Having (1) a charge of glass at a known temperature and weight, (2) a forming machine with a known cycle of time when running at a given speed, and (3) a finished bottle of a specified temperature discharged from the said machine, it may be possible to estimate the heat dissipation at each stage of fabricating, and from this information determine the correct proportions and dimensions of molds. This method of attacking the problem would probably appeal to some members of the glass industry, rather than the crude trial and error methods in common use, so it may be interesting to consider some of the factors that must necessarily be taken into consideration. Depending on the size of the article to be made, the initial temperature of the glass, or charge, delivered by the feeder may vary from about 1950° to 2200° F., optical temperature, and this charge of glass commences to dissipate heat immediately after it emerges from the feeder orifice.

Taking the case of a bottle made by the Lynch type of blow-and-blow process, and assuming a well-formed gob is accurately deposited into the parison mold so that a minimum of settling occurs, the complete cycle of the machine can be divided in sections and considered in a certain sequence which is sometimes subject to change. The transfer of the heat from the glass to the mold will begin immediately after the charge is received by the mold as shown in Fig. 1, although at this stage the glass is not uniformly in contact over its whole surface. The settle-blow head, or compacting head, is now applied to fill the neck ring, causing fairly uniform contact between the parison mold and glass as indicated in Fig. 2 and, during this period, a cooling effect is produced on the top face of the glass charge due to leakage through the mold joint. This should be taken into account.

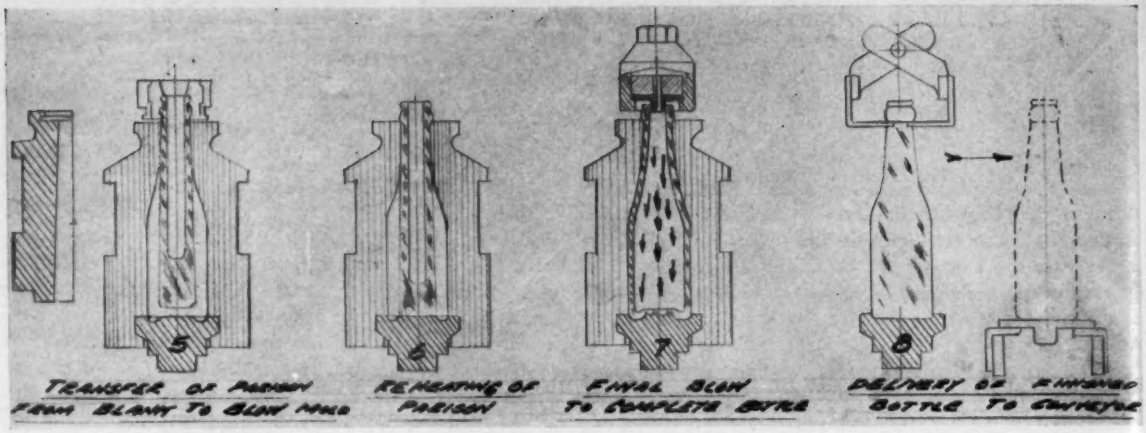
The plunger and settle-blow head is now removed, and the mold is indexed to the counter-blow position as shown in Fig. 3. Sometimes the parison is inverted during this period and sometimes not until after the counter blow. The last two steps of the parison formation are probably the most important parts of the parison cycle, because the extent of chilling during these periods largely determines the volume of glass remaining sufficiently fluid to be displaced during the counter blow. As soon as the mold comes to rest after inverting, the baffle plate is brought down into position, as in Fig. 4, and the counter blow is effected. This action is almost instantaneous so that the heat transfer is now occurring from the whole outer surface of the completed parison, although obviously not at the same rate over the whole surface, since the glass displaced during the counter blow. As soon as the mold mass which has retained the most heat.

The parison mold now moves on the position, Fig. 5,

Paper presented at the Fifth Conference on Glass Problems, University of Illinois, May 21, 1938.



Figs. 1 to 4. Formation of parison in blow-and-blow process.



Figs. 5 to 8. Formation of container in blow mold—blow-and-blow process.

at which the completed parison is transferred to the blow mold. During part of this moving period and until the blow mold closes around it, the parison is exposed to the surrounding atmosphere. Then follows a period of reheating of the chilled inner and outer surface, or skin, of the parison before final blowing can take place. During this time the parison is hanging in the blow mold as illustrated in Fig. 6, but not making contact with it except at the neck and, possibly, for a short time on the bottom plate. Finally the glass is blown against the inner walls of the blow molds, and continues to make contact more or less until the finished bottle is removed from the blow mold. Figs. 7 and 8 show this part of the action.

The foregoing list, although formidable, does not of course include all the factors that would need to be taken into consideration in a scientific study of the problem. For instance, some means for measuring the initial temperature of the mold charge would have to be provided and the temperature difference between the surface and the mass of the charge would have to be estimated. Also the fact that up to 1,000 cu. ft. of air per minute may be used for force cooling of each parison and blow mold would have to be taken into consideration. When this portion of the problem has been solved the scientific solution would be available for any given article, given the initial temperature of the charge of glass and the speed of manufacture.

Since no scientific method for solution of the problem of mold design is yet available, consideration must be given to some sort of an empirical rule, based on the correlation obtained by the more homely "rule of thumb" methods usually employed. It will be agreed that the aim of the mold designer is to produce molds which will produce the greatest number of bottles of the best quality under a given set of directions, that is, with a specified feeder glass composition and a worthy and successful forming machine. Whether the aim is best quality, greater quantity, or a compromise, the main problem in bottle production lies in the ratio of the volume of glass in the article to the internal volume of the parison mold and the relative shape of the parison to the blow mold.

If the parison is made too small, trouble is frequently encountered in depositing the charge of glass in a compact mass in the neck and shoulder of the parison mold, but unless this is done it will be almost impossible to produce a first class article. This applies more particularly to the oval shaped parison, when the major axis is greater than the minor axis. Other effects of small parisons are low manufacturing speeds and very unstable results. It will be obvious that a small parison, having a thick wall of glass and a small radiating surface, will require a greater time to dissipate its heat. The cavity formed by the counter blow may be slightly unsymmetrical. In a parison of this type a comparatively large mass of glass at the upper part remains fluid and, when the final blowing air is applied, a bottle with very uneven distribution of glass in the base results, somewhat like a wedge bottom. From my own observation I would say that a small parison, although capable of producing a percentage of bottles of excellent quality, not only entails a low operating speed but also is poor in performance and results in a low percentage of packed ware.

Larger parison molds make higher speeds possible, but produce very poor quality ware if too large. As to glass distribution, the side of the bottle will be very wavy, producing a shadow effect generally known as "settle wave." This settle wave probably can not be eliminated entirely by correct parison mold design, because this feature is almost uncontrollable in the blow-and-blow process except by a plunger settle device which, by the way, also fails on some parisons. But it can be minimized. The distribution of the glass in a parison which is too large appears something like that as shown in Fig. 9. A very large parison gives up so much heat to the parison mold that the residual heat is scarcely sufficient to reheat the skin of the parison to a suitable degree for final blowing, or for heating the mold sufficiently to produce ware that has a good surface.

The ideal parison design should be somewhat as shown in Fig. 10, having uniform thickness of walls, with perhaps slightly greater thickness in the corners to avoid thin spots in the sides of the finished article immediately above the base. Unfortunately it is very difficult, if not impossible, to produce parisons like this in commercial operation, but I have noted a very definite relation between the volume of glass and the volume of the parison mold which I believe gives improved results. This makes it possible to estimate the mold volume much closer,

but the parison will not necessarily have uniform wall thickness as shown in Fig 10. On the contrary, there is invariably an unevenness at or about the line level at which the charge of glass stands, when the charge is deposited in the parison mold as shown in Fig. 11.

Very little control of the volume of glass displaced, when the counter blow is effected, is possible. The volume is dependent on the extent of the chilling effect caused by contact with the iron before the counter blow is applied. The volume of glass displaced could, to some extent, be affected by varying the pressure and period of the settle blow to increase or decrease the chilling effect, and also by varying the pressure of the counter blow air, if these adjustments were available. Variation in the pressure of the settle blow air, however, is required for controlling the formation of the finish, while the pressure of the counter blow air must be adjusted to set the parison firmly without producing too much chilling effect on the completed parisons.

When manufacturing wide mouth ware, it is true that the general shape of the cavity formed by the counter blow can be varied to some extent by altering the shape of the plunger. I have never seen it so manipulated, however, to remove the unevenness at the point in question. But in the case of narrow neck ware any variation of the plunger tip is not effective at all beyond the portion of the parison corresponding with the neck of the bottle. Sometimes choked necks can, of course, be eliminated by dressing plungers.

After one has determined the volume of the parison mold, the next point for consideration is the contour of the parison in relation to the shape of the finished article. In the case of round and square bottles having parallel sides and a cylindrical form there is, of course, no problem, but the question arises whether cylindrical or flared parisons are the more satisfactory. By a flared parison I mean one having a cross section area from the body towards the end, remote from the neck, such as shown in Fig. 12. Excellent results have been obtained from a cylindrical form of parison, but I do not believe that it gives such good results as a properly proportioned parison of the flared type. The cylindrical form appears to give good results when all operating conditions are perfect, that is, when a charge of glass of uniform temperature and proper shape is accurately charged into the mold and the forming machine is properly adjusted. But if any of these factors are not kept to high standards, defects will appear in the ware in the form of thin spots in the sides and wedge bottoms.

The above factors cannot be neglected if flared parisons are used, but I am definitely of the opinion that more stable results can be obtained with less skillful operation when using a flared parison. This is particularly true when making a bottle with an unusually heavy base. Slight flaring is of no use, and, to be effective, the size across the flare must approach somewhere near the size of the blow mold, as shown in Fig. 13. Nor can a small parison mold which has already been made in the correct volume ratio to the glass volume be successfully flared, because a bottle having very thin sides immediately above the base would be produced. The flared portion should have a very easy curve. If a small radius is used at any point a shadow effect will be produced in the ware.

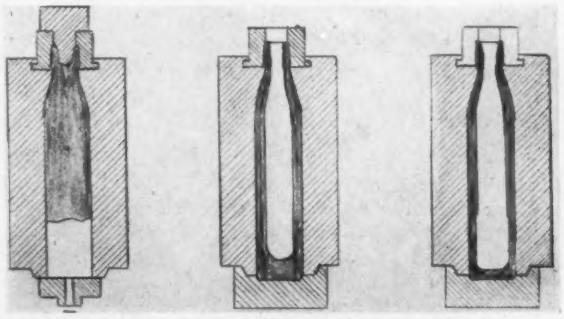
Care should be taken to avoid aggravation of the baffle mark. Since practical considerations limit the closeness of the joint there always exists the tendency to form a chilled fin on the blank or parison. An exaggerated or abnormal fin will not reheat properly and, therefore, not blow out smoothly. The extent to which this defect may occur depends on three major factors: First, poor baffle plate or parison design; second, poor mold workmanship; third, and not least, setting of the blank mold and baffle. Fortunately these are readily controlled.

The original mark at the baffle joint may be comparatively harmless if the parison shape allows its proper reheating. The manner in which the iron "surrounds" the glass parison at this joint is a major controlling factor. Where there is a rather sharp change in contour of the parison at the joint, excessive chilling and inadequate means for reheating result in serious baffle marks. On the other hand, when only a gradual change of curvature exists the chilling is less and reheating capacity is sufficient to reduce the marks to a minimum. It is good mold designing practice to limit the curve of the parison just below the baffle mark to a minimum radius of 3/16 inch. It is generally a serious mistake to neglect these precautions and then attempt to offset them by juggling machine timing. Such an attempt usually causes other defects, possibly even more objectionable. On the other hand, too long and too heavy contour blow and too short parison reheat, each matters of timing, may aggravate the baffle mark.

Wide mouth bottles made by the narrow neck process usually present more baffle plate mark difficulties than those having smaller finishes. The time required for setting of the wider finishes constitutes a speed limitation and increases, likewise the setting time of the original baffle mark. With such ware, therefore, special care should be taken in the designing, manufacturing, and setting of molds.

There have been many attempts to list the numerous ware defects and their causes which accompany mechanical fabrication and conditions on fabricating machines. Fig. 14 deals more specifically with the condition of glass, the molds, and alignment of corresponding mold parts on the press type, blow-and-blow type, or press-and-blow type of machine. The defects indicated, and their probable causes are as follows:

1. Corkage Checks—
   Glass too cold.
   Too much settle blowing air.
   Plunger too cold.
   Plunger in contact with finish too long.



Left to right: Fig. 9. Glass distribution with parison too large. Fig. 10. Ideal design of parison. Fig. 11. Uneven surface when charge is deposited in the parison mold.

2. Offset Finishes—
Dovetails on mold finish ring too small.
Mold size for rings dovetail too large.
Carbon on faces of joints causing blanks to stand open. resulting in loose finish rings and large finish seams.

3. Bulged Finishes—
Finish not set hard enough.
Not enough settle blow.
Plunger contact time too short.
Not enough counterblow—flow head too short and resting on top of finish.
In case of press and blow, check finish cooler device.

4. Neck Ring Seams—
Plunger shoulder diameter too large.
Ring diameter too small for blank.
Blank mold fit for rings too large.
Rings not properly matched.
Blanks standing open due to carbon accumulation.
Dirty ring equipment and plungers.

5. Bent Necks—
Mold equipment running hot pulling bottles sideways.
Take-out station too early.
Take-out jaws out of alignment with blow molds.
Neck rings running hot—not releasing ware.
Machine running too slow.
Check recommended feeder drop and shape.

6. Choked Neck—
Glass too hot.
Plunger too long or possibly too short.
Plunger in contact too long with glass.
Blank or finish ring running too hot.
Molds are running hot and dry—try spraying with Renite.
Machine running too slow.
Do not have too much of a point on feeder drop.

7. Light Shoulders—
Glass is too hot.
Parison not set enough, lets parison run in blow mold.
Blank shape does not suit blown bottle to be made (Shoulders of blank running too small).
Try blowing up sooner.

8. Blow Mold Seams—
Carbon or oil sediment, or fine glass. between mold halves.
Interlocking bottom plate too large or mold halves not locking around component parts.
Glass between neck ring or bottom plates.
Joints not machined true or scraped.
Not enough gripping on molds.
Molds spreading apart during charge.

9. Blank Mold Seams—
Neck ring diameters too small for component blank molds.
Blank not matched with neck ring.
Carbon or oil collection between halves.
Neck rings not having enough lock pressure.
Warped mold equipment.

10. Ware Sticking to Molds—
Glass too hot when taking out.
Machine running too fast.
Molds do not have enough body, thus running too hot.

11. Light Sides in Ware—
Check feeder to see if drop is cold on side and true.
Uneven distribution of wind.

12. Heel Taps—
Uneven temperature of feeder drop—check feeder.
Parison not blown up full and running metal too soft.
Blanks too short for corresponding blow mold.
Blanks running too hot, parison sticking to mold.
Cooling not even on both sides of parison mold.
Neck rings not absolutely in line with each other.
Neck in blow mold smaller than blank, causing hold up of parison (never should be less than 1/32" smaller).
Blow mold runnning too hot—Many causes, check into metal body.
Heel taps are usually caused by an improper combination of parison temperature, parison length and initial final blow time. A proper combination is required to balance mechanical actions of the forming machine.

13. Bottom Plate Seams—
Bottom plate out of alignment with blow molds.
Too much clearance when designing equipment for expansion.
Improper means for locking bottom plate around molds.
On irregular shaped bottoms lining up pin out of line.

14. Baffle Plate Marks—
Parison too hard, too heavy a counter blow, or too long a period.
Parison reheat time too short, not permitting the inner skin to reheat the outer skin or enamel.
Baffle out of alignment with top of blank, or too much clearance, not properly matched.
Bad baffle plate designing.
Baffle not set properly in blank.

15. Glass Too Cold—
Finish set too hard.
Plunger contact too long, freezing finishes.
Mold closing too late.
Take-out or tongs possibly may be too much out of line with mold.
Take-out unit or jaws set too high.
Too much wind blowing on finishes.

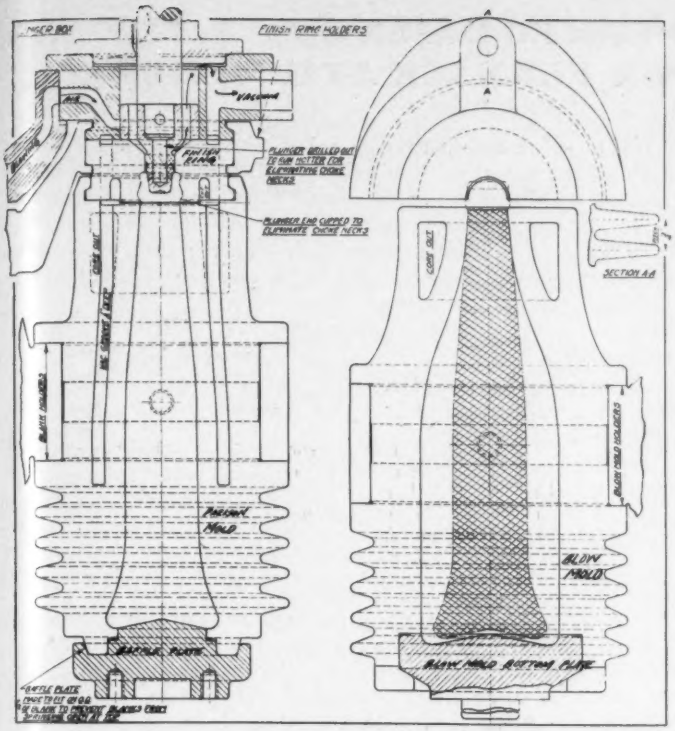
15a. Finishes Not Filled—
Glass too cold.
Glass hanging up in delivery.
Not enough vent around plunger or in neck ring.
Not enough settle blow.
Plunger too long.
Blanks too hot or dry, glass hanging up on side of molds.
Settle blow air applied too soon.

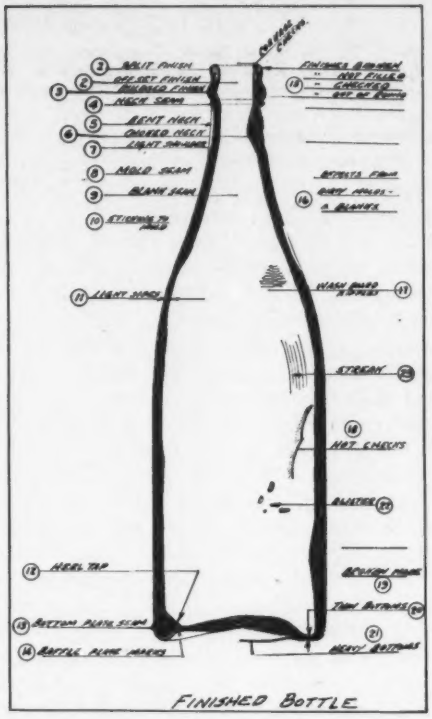
15b. Checks in Finishes—
Glass too cold from feeder.
Plunger adjustment too high or too low.
Neck ring equipment out of alignment.
Neck ring not relieving from ware, thus tearing the finish.
Take-out jaws pinching neck or finish of ware.
Take-out jaws made out of a material that does not stay hot.
Wind for cooling finishes too strong.

15c. Finishes Not Concentric or True—
Not enough counter blow.
Plunger contact too long.
Neck rings running too hot, not giving glass in finish any set.

16. Some Results From Dirty Mold Equipment—
Streaky ware.
No luster to ware.
Poor quality ware.
A general poor production report.
A lack of interest to produce good quality of ware.
A mold is the heart of fabricating good quality of ware.

17. Wash Board or Ripples in Glass Ware—
Drop not entering mold properly or centrally.
Uneven temperature of drop.
Drop too small and not proper shape for the blank mold.
Funnel too large for body or diameter of blank.
Carboned, dirty, uneven or hot funnel.
Blanks too hot or too cold.
Dirty or rough blank molds.
Drop too large for blank mold, causing settling of glass.





Left to right: Fig. 12. Parison mold showing proper design of flared parison. Fig. 13. Blow mold showing proper proportion between parison and finished article. Fig. 14. Section of finished ware showing various defects.

18. Hot Checks in Finished Ware (Coming on conveyor)—
Molds running too hot, makes ware stick to mold halves.
Too much blowing pressure or not efficient regulators on this air.
Not enough cooling wind on molds.
Machine running too fast, making equipment run hot.

19. General Broken Ware—
Feeder discharging cold glass.
Machine running too slow.
Lehr condition not perfected.
Too many bottles on conveyor, taking too much time to get into lehr.
Cold mold equipment—either blanks or blow molds.
Too much blowing air after transfer in the blow molds.
Too much cooling wind.

20. Thin Bottoms—
Glass too cold.
Under-weight of glass.
Incorrect plunger contact time in relation to the counter-blowing. and sometimes blowing through in blank mold.
Parison reheat too short.
Blank shape incorrect in relation to blown article.
Final blowing up of article too soon. not allowing enough time for preheating of parison outer and inner enamel.

21. Heavy Bottoms—
Glass too hot.
Over-weight of charge.
Parison reheat too long—Parison stretches too much on to bottom of blow mold.
Blank shape not correct in relation to finished article.
Half bubble parison, thus allowing all the glass in the bottom.
Parison too soft, not enough counter blow, or machine running too fast.
Counter blow not long enough and too light.

22. Blisters in Finished Articles—
Generally in the glass or chemical condition of the glass.
Not properly refined in the melting chambers, possibly tank or feeder nose running too hot.
Cold glass collecting on needle of feeder plunger.
Not enough fire applied directly in path of glass near feeder plunger.

23. Streaks on Side or Internally—
Brush marks or possibly oil marks.
Dirty plungers and rings.
Excessive swabbing—Too much oil used before charging in blanks.
Very fine vertical laps in the finished article are caused.
Cold glass.
Glass chilling from feeder orifice through trough delivery.
Glass hanging up or too slow in leaving funnel.
Blank shape and funnel bore not good design.
Needle in feeder not pulling cold glass back up into feeder to remelt possible shear marks, causing chilling of glass for next delivery.
Gob too long and diameter too small.

24. Lap Marks—
Drop from feeder too long—Either too cold or hot.
Shears not properly aligned.
Drop too short, hanging up in funnel.

In conclusion, it has been our general experience that the design of mold equipment for various mechanically-driven machines is almost a local factory problem. This is especially true of blank molds, as mold equipment often goes into the various plants and it is then found necessary to alter the parison or blank molds. Also the composition of the glass, the temperature at which it is delivered to the molds, and the speed and cycle of operation of the machine are all important, because, when the operation and the cycle of the machine are changed, the appearance of the finished ware and the quality are likewise changed.

GLASS COMPOSITION AS DEPENDENT UPON FURNACE ATMOSPHERE

An anonymous writer in *Sprechsaal* for December 2, 1937, develops some interesting ideas on the effect of oxidizing and reducing atmospheres on glasses in which salt cake has been used in the batch.

Control of glass compositions by routine analyses involves placing reliance upon the accuracy of these analyses within ± 0.1 per cent. If it is assumed that the melting process is carried on under precisely the same conditions from time to time, and that the raw materials are constant in composition within the limit specified, the glass composition ought not to vary more than the analytical error. The conditions requiring most careful watching are the moisture content of the batch materials, the weights of the ingredients as mixed, and the furnace temperatures, since these affect the volatilization of alkali. All of these are capable of being closely controlled.

A more difficult condition to control is the degree of oxidation or reduction in the flame gases. This influences, in particular, the more or less complete decomposition of sulphate or salt cake, and consequently the residue reported as SO_3 remaining in the glass. This oxide, about which we know comparatively little as to its effect upon viscosity and other properties of the glass, may be present in quantities varying from a few tenths per cent to approximately one per cent in the finished glass. We are probably justified in assuming that variations in the SO_3 content are at least as important as variations in the Al_2O_3 content, to which we assign great importance.

Every oxide present in the finished glass plays a part which depends not only upon its own properties and the place which it occupies, but it has an influence because it suppresses to a greater or less extent the content of major oxides in the glass. This consideration demands that we pay more attention to this SO_3 content.

A tabulation is made showing the changes in composition to be expected as the SO_3 content is altered by different conditions:

	Melt	
	Oxidizing	*Reducing*
SiO_2	70.20	70.41
Al_2O_3	0.42	0.43
Fe_2O_3	0.13	0.13
CaO	13.51	13.55
Na_2O	15.14	15.18
SO_3	0.60	0.30
	100.00	100.00

It thus appears that the silica content may change not less than 0.2 per cent for no other reason than the variation in SO_3 content consequent upon furnace atmosphere. This difference is twice the analytical error. It furnishes one more reason for the failure of analytical results to check with calculations from the batch. It is also enough difference to account for a difference in the behavior of the glass upon working. It is undoubtedly true that the amount of SO_3 present in the glass has an important influence on its plaining, and it must also have an influence on the general behavior of the glass. It must have some effect on the tendency to devitrify. All these considerations are good reasons for paying attention to control of furnace atmosphere whenever salt cake batches are being employed.

SOCIETY OF GLASS TECHNOLOGY MEETS

A meeting of the London section of the British Society of Glass Technology was held on May 4 at the Research Laboratories of the General Electric Co. Demonstrations of glass-blowing which were witnessed included large diameter glass to metal joints made on lathes, the operation of a machine for making multiwire ring "pinches" for cathode ray tubes. Different types of electric discharge tubes in operation, as well as their manufacture, were also shown.

C. I. Marchand presided over a meeting later. Among those who spoke were: I. C. P. Smith on "The gauging of glass tubes with some remarks on the use of hard glasses"; A. C. Jeffkins on "Some observations on the chemical testing of neutral glasses." Each talk was followed by lengthy discussions.

THE FIRST GLASS BLOCKS?

There is considerable controversy as to when the trend toward building with hollow glass blocks originated. Some believe that they were first used in Holland about 25 years ago, while others declare that various European glass companies experimented with glass in block form long before that. This latter belief is substantiated by Geves George Kenny, a Chillicothe, Ohio, architect.

While prowling through the Rhine River valley village of Andernach, Mr. Kenny came upon the alley-side wall of a dilapidated barn. His eye was attracted by what appeared to be a dirty window. Closer inspection proved it to be a panel of glass blocks. They were hexagon-sided and shaped like bulging vases with both ends closed. They were hollow, somewhat like today's straight-sided Insulux glass block, but hand-blown like an old bottle and without the important vacuum characteristics of today's glass blocks.

Incidentally, the research department of Owens-Illinois reveals that the first commercial shipment of Insulux glass blocks was made to the Department of Air Commerce for an airport at Kellog-Wardner, 75 miles east of Spokane, Wash., on April 20, 1935.

GOGGLES MAY END GLARE

American Spectacle Co., New York, has recently developed goggles with two tone lense as a protection against glare while motoring. The lower portion of the lenses offers clear vision gradually shading into a dark portion above. All the man at the wheel has to do is tilt his head. The company points out that the lenses also offer safety-glass protection.

THE FIFTH GLASS CONFERENCE AT URBANA

Production men and engineers, representing fourteen states and one foreign country, held an open forum on glass factory problems at Urbana, Ill., on May 20-21. Not counting faculty and students of the University, the attendance lacked only three of an even hundred, making the largest and incidentally the most enthusiastic audience of any in the five year history of these meetings, which are conducted by the Department of Ceramic Engineering of the University of Illinois.

The opening session was given over to batch problems, with particular emphasis on methods of handling. Several outstanding installations, such as those at the Ottawa plant of Libbey-Owens-Ford, the Streator factory of Owens-Illinois, the River Rouge plant of the Ford Motor Company, Corning and Ball Bothers, were described in considerable detail.

Beginning at the beginning, with the unloading of raw materials, some companies reported marked economies from the use of new types of tank and gondola cars. When it comes to getting raw materials into the plant and to the tank, few factories have ideal installations of batch handling equipment, as many of the older plants simply are not built that way. But production men are studying those systems and methods, which are proving more efficient, against the day when they will be given an opportunity to use them, and meanwhile are appropriating such parts or features as circumstances permit. The importance of the proper type of storage bins received further emphasis, and it is quite probable that the next few years will see new developments here. The place to add the cullet, wet batch or dry batch, are still open questions, apparently; the proponents of each being as staunch in their convictions as ever. There is a general need for a cullet crusher more efficient than any available today. And batch briquets, looked upon by some as a fancy Ford frill, seem to offer real production economies, not to mention improved working conditions. Difficulties in the manufacture of briquet molds are apparently the main obstacle to a wide use of briquets.

At the Saturday morning session, the plant men turned their attention to the other end of the tank and discussed container molds and mold materials. Glassmen showed a surprising interest in and knowledge of metallurgy, although the professionals disagreed at times with some of their theories—normalizing and annealing, for example. There has been some limited experimentation with mold temperatures that needs to be further and more thoroughly investigated. The thought was advanced that in an effort to achieve machinability, glassmen may be saving at the bung and wasting at the spigot, since the saving in down-time and in longer runs may often more than offset higher machining costs. An interesting thought was brought out that perhaps the thing to use might be a porous metal for the parison mold and a hard, dense metal for blow molds.

The extent of the interest in the program was attested by the discussions following each paper, in which a great number participated. In fact, the discussions resulted in prolonging each session far beyond its scheduled time.

The Urbana conferences, of which this one is the fifth, have filled a definite need in the industry. Although the American Ceramic Society and the Glass Container Association hold meetings of an educational character, these deal with scientific and merchandising phases of the industry. Urbana provides the one and only forum for production men. While it is true that glassmaking cannot progress in this country and will not progress without an aggressive research program, and also that the semi-

VISITORS AT THE FIFTH ANNUAL CONFERENCE ON GLASS PROBLEMS, UNIVERSITY OF ILLINOIS, MAY 20-21.

Left to right, first row: R. K. Hursh, D. M. Hansen, Vaughn Kerr, V. J. Cox, D. D. Buress, F. Steinhoff, H. C. Vormelker, L. C. Storey, H. H. Hanna, I. G. Fowler, A. E. Badger, W. F. Huntley, C. W. Parmelee, F. E. Bardrof. Second row: F. R. Pruden, J. T. Ogden, Joseph Early, G. H. Terrill, Lawrence Meharg, G. B. Langer, W. J. Mathews, E. E. Milner, A. J. Jerome, Y. R. Cornelius, A. D. Schiller, F. E. Bager, A. Rankine, Jr. Third row: A. R. Schlehr, C. B. Garwood, A. T. Hellmers, O'Mara White, C. P. Overmyer, A. W. Dodge, Z. C. Kline, A. E. Hill, J. R. Parsons, E. E. Milner, Jr., J. C. Woodward, H. Barr, R. L. Shute. Fourth Row: E. F. Schaefer,; D. S. Foote, C. S. Linder, H. J. Shaner, F. G. Schwalbe, C. O. Briner, V. Ritter, F. E. Jewett, A. J. Paul, D. W. Ross, R. Newcomb, R. T. Gutman, J. S. Herzog, H. M. Louden. Fifth row: C. L. Arnold, H. W. Hess, E. V. Ogg, H. R. Rack, L. D. McVicker, Fay Tooley, G. G. Hanson, A. L. Duval d'Adrian, R. R. Board, J. L. Bacon, A. K. Lyle, A. J. Diener, W. K. Berthold, H. T. Cox, Jr., M. A. Kundall, R. G. Ehman, L. D. Dodd, E. E. Burke, E. B. Carr. Sixth row: C. F. Herasig, J. W. Wright, M. E. Nagle, A. E. Williams, H. H. Crimmel, W. J. Power, Robert Galbraith, J. L. Crawford, F. R. Motsch. Seventh row: James Arrandale, E. J. Bittman, D. I. DuBois, H. A. Wadman, H. H. Holscher, H. B. Harris, J. A. Pask.

Professor C. W. Parmelee, who is largely responsible for the success of the Urbana conferences.

annual conventions at White Sulphur are of vast importance in a merchandising sense, still in the last analysis glass is made *in* the factory and *by* production men. The glass industry owes a great debt of gratitude—a debt that it may not fully realize—to Professor Parmelee and his associates at the University of Illinois for providing a forum on factory problems.

The following are summaries of the papers read at the conference. Two of the papers, "Feeding Batch to Tank Furnace" and "Mold Faults and Remedies" are printed in full in this issue. Mr. Cornelius' paper on Electric Melting will be given in detail in the July number of THE GLASS INDUSTRY.

Batch Handling. *By A. D. Schiller, Corning Glass Works.*

For the preparation of a satisfactory batch attention must be paid to the fundamental raw material requirements from the standpoint of quality, storage and mixing. Tests for physical and chemical properties should be made on each incoming shipment, if possible, or at least periodically. Sand should be screened before storage and bins should be designed to prevent segregation and dampness. Bins for soda ash should have hopper bottoms and arranged so that shipments can be used in rotation. Nitre, salt petre, salt cake, etc., should be crushed and screened before using. Feldspar shipments should also be used in rotation and the bins should have tight gates. Borax and boric acid should be stored on the floor as they tend to cake if stored in bins. Affinity of potassium carbonate for water necessitates storage in a warm, dry room.

Raw materials should be purchased in bulk, if possible, to reduce unloading cost and minimize the health hazard. Bulk shipments are usually preferable for sand, borax, boric acid, feldspar, soda ash, dolomite lime, hydrated lime, salt cake and nitre. Covered gondolas and tank cars have advantages over box cars for bulk shipments and all shipments, whether bulk or package, should be labeled for reference. The standard method for unloading bulk materials is by bucket elevator with spouts to the bins, but at the main plant of Corning Glass Works at Corning incoming cars are dumped into a hopper from which the material is discharged into skid buckets holding about 3,000 lb. By means of electric trucks the buckets are then carried up four floors on a freight elevator and dumped into the bins. Two men unload a 50-ton car in eight hours.

Floor scales of the dial type are preferable for speed and accuracy and should be located centrally to avoid too much walking in gathering materials and in going to and from the mixer. A suitable mixer should be sturdy in construction with ample capacity and arranged so that it can be conveniently and thoroughly cleaned. Batch wagons are made of steel or wood. At Corning skid legs have been substituted for wheels and the wagons are transported by electric trucks.

Most of the cullet at Corning is also transported in skid hoppers by electric trucks. Large quantity cullets are crushed and plans are being made to also crush miscellaneous pot and small tank cullets. The cullet crusher is fed by a vibrating feeder and the crushed cullet is then carried to the top of the building by a 110-ft. bucket elevator. It then passes over a magnetic separator and into the bins. Cullet is automatically weighed into the batch by means of an overhead scale, a vibrating feeder and an electric eye. Miscellaneous cullets, of which there are hundreds, are stored in barrels and bins.

Over 100 different raw materials are used at Corning. It is not practical to store all in overhead bins, so small service bins on casters are used. The materials are gathered and weighed and dumped into the mixer, the cullet being loaded first. Mixing requires from 4 to 15 minutes, depending on the batch.

Batch handling systems at other Corning Glass Works plants include various combinations of similar equipment, one having a traveling mixer of the drum type and another being equipped with automatically controlled scales with a gathering belt conveyor discharging to the mixer.

After long experience the author mentions the desirability of seeing the material as it is being weighed and as it is being loaded into the mixer, in order to be sure what is going in and what is coming out, and suggests that some glass quality problems might be traced to a closed batch plant of the "modern" type. He expresses the opinion that the trend toward closing the system and hiding the materials from sight is not entirely necessary for cutting costs and minimizing the health hazard.

In the design of a batch plant the health problem is of prime importance. In old plants dust should be eliminated as much as possible at the source and sand handling equipment should be closed as much as possible, even at the receiving end. The mixer should be isolated so that the dusty area is concentrated. Proper ventilation and enforced use of respirators are other important factors.

Discussion—Burress called attention to the fact that the design of the batch plant is affected by the design and construction of the existing glass plant, especially where the use of mechanical handling is considered. He also agreed with the author regarding the necessity of a close check on raw materials. Storey mentioned the tank cars used by General Electric for sand shipments, stating that this method of shipment increased costs about 5 cents per ton. These tank cars were not equipped with unloading conveyors as were the tank cars described by the author and used by Corning. He concurred with Schiller in the opinion that cullet should be mixed with the batch. Herzog asked if the speaker had found any difficulty from

over-mixing. Schiller stated that tests at Corning showed demixing after the mixing process had been continued for about 20 minutes and that all cycles were thereafter shortened.

Batch Mixing and Handling. *By E. E. Milner and E. E. Millner, Jr., Ball Brothers Co.*

Although methods of unloading and storing raw materials and the process of weighing, mixing and distributing unit batches have been sadly neglected, they are now receiving considerable attention and the increasing demand for better working conditions is sufficient reason for many improvements being made. The main objectives are the production of glass free from seeds and cords, the elimination of dust within the batch plant and means for preventing separation, together with the elimination of light dust in the furnace charge. Many existing batch plants can be improved by incorporating recent advances in the design of structures and machinery. Unloading of raw materials by power shovel is now almost universal, the use of hopper-bottom cars is increasing and the self-unloading tank car offers excellent possibilities. In a new plant design track hoppers should be installed for the future use of the improved equipment, even though shovels are used.

Bucket elevators to storage bins should have some type of feeder in the elevator boot to prevent overloading, and the pivoted bucket or Peck carrier elevator has certain advantages. Raw material bins should have conical bottoms. Hollow vitrified tile bins are not affected by moisture and require no treatment of internal surfaces. For steel bins some kind of a permanent lining is needed and a rubber coating is a possibility. For gathering materials a simple, accurate and inexpensive arrangement consists of a gathering car with compartments for each of the ingredients, each compartment having a bottom gate controlled by a convenient lever and holding enough for two complete batches. After the car is filled it is moved to the weigh hopper where the ingredients are weighed out. The weigh hopper is placed at the track level and is furnished with a large dial scale. Advantages include a single rigidly-mounted scale that may be placed in a dust-tight enclosure, flexibility of arrangement of material bins and mixing position, use of two or more mixers if necessary, and ease of installation without interruption of production.

Mixer should have ample batch capacity and should be fitted with dust-tight loading hoppers and fully-enclosed unloading chutes. Horizontal pan-type mixers are giving good results. Some form of magnetic separation is essential somewhere in the batch handling system. In regard to the feeding of cullet and batch, the authors expressed the opinion that cullet properly crushed and added to the batch in carefully proportioned amounts contributes to the uniformity of the glass. However, no positive information that the random charging of cullet is harmful seems to be available.

Excessive handling and repeated loading and unloading of the mixed batch storage bin is the principal cause of batch segregation. High-speed elevators and conveyors cause separation at the discharge points, but the greatest amount of separation occurs as the batch falls into the storage bin, especially when the bin is nearly empty. Small unit containers for mixed batch have proved satisfactory, especially when handled on an overhead monorail track. This system is, however, difficult to install in existing plants. Briquetting of mixed batch gives complete freedom from dust and separation, both at the mixer and in transit.

Discussion—In response to a question Vormelker stated that one General Electric plant mixes cullet with batch and another does not, the latter having a comparatively light load on the tank. Lyle mentioned difficulties from tramp iron in foreign cullet, together with the introduction of a variable into the batch with such cullet. An inquiry by Hill regarding the use of water in the batch brought forth a reply from Schiller that in certain batches the addition of water prevents segregation, 1/10 per cent of water being added to Pyrex batches at Corning. Jewett raised the point of the maximum proportion of cullet used in a batch and Hill mentioned an English plant using 100 per cent. Mathews reported trouble with foreign cullet at Sterling Glass necessitating reduction of cullet to 21 per cent. Burress thought the upper limit of domestic cullet for container batches should be about 35 per cent.

Feeding Batch to Tank Furnaces. *By V. C. Fugman and H. I. Vormelker, General Electric Co.*

This description of the type of screw feeder used in General Electric glass plants is published in full on page 213 of this issue of THE GLASS INDUSTRY.

Discussion—A lively discussion immediately started regarding the movement of the batch in the tank after introduction by a mechanical feeder. In this discussion the tendency of the batch to move or "snake" directly to the bridge wall was mentioned, but there was no unanimity of opinion that this action could be attributed to the feeder. A letter from Oakley of Corning was read, in which he expressed the opinion that such movements were entirely due to the convection currents in the tank. Milner reported on an application of the Hazel-Atlass feeder in which the movement of the batch to the bridge wall was eliminated by the use of a tapering doghouse, the opening to the tank being wider than the back end where the feeder discharged. Shaefer thought there might be some force stronger than convection causing batch movement and introduced by the action of the feeder, but that the use of several feeders as described by the authors should be satisfactory. Arrandale mentioned the possi-

Authors of the papers. Left to right, front row: J. W. Wright, Professor Parmelee, G. B. Langer, A. D. Schiller, E. E. Milner. Back row: Z. C. Kline, A. E. Badger, Y. R. Cornelius, F. G. Schwalbe, H. I. Vormelker, E. E. Milner, Jr.

bility of under-feeding, stated that the use of heavy cullet causes the batch to sink and also expressed the opinion that the movement of the batch is due to convection currents. During the discussion several speakers mentioned control of the convection currents by control of the firing.

Batch Weighing Trends. *By A. J. Jerome, Toledo Scale Co.*

In early methods of batch proportioning a large box or hopper was filled to certain marked levels by means of wheelbarrow and shovel, but as the need for better control became more pressing a weighing scale entered the picture. The scale was located under the box and a considerable improvement in the uniformity and accuracy of the batch proportions became possible. Supply bins had to be closely grouped around the weighing hopper and this requirement became more troublesome as the size of the batches increased and as the batches were required at more frequent intervals. Such conditions were relieved by the location of the bins in a line and the transfor of the weigh hopper to a portable car. The batch gathering weigh car substantially reduced crowding around the scale and provided a satisfactory means for handling the batch between the supply bins and the mixer, but it has two serious shortcomings. First, the smaller ingredients must be weighed on a heavy insensitive scale, selected of necessity to accommodate the combined weight of the batch. Second, the use of the scale as a truck introduced heavy loads and rough handling in an abrasive atmosphere which quickly destroyed the original sensitivity of the scale. Scale engineers recommended the separation of the scale from the truck and this called for the installation of scales of proper size and sensitivity under each of the supply bins, thereby improving accuracy and decreasing scale maintenance. So far as the human element would allow, this arrangement, together with the batch-gathering car, permitted batch proportions approximating those set up by the control chemists.

Present fully-automatic batching installations are the direct result of efforts to further improve accuracy and eliminate the dust hazard. The important advantages are closely connected with the human factors involved in manual batching operations. The automatic installation insures the utilization of the full basic accuracy of the scale and eliminates such manual errors as incorrect weight, adding one ingredient twice or leaving one out altogether.

Bardrof of *Glass Industry* directs "posing" the group, with Miss Shierry of the U. of I. staff assisting.

The automatic installation can also be enclosed so that the batch plant can be rendered almost completely dustless, and a single operator can control every detail of the weighing, collecting and mixing, as well as the distribution of the mixed batch to the furnace. An example of a completely automatic batch plant is now in operation at the Libbey-Owens-Ford Glass Co., Ottawa, Ill., and was illustrated and described in the April issue of THE GLASS INDUSTRY. An interesting and important feature of the L-O-F installation is the control of the minor chemicals, which are delivered to the batch as it passes to the mixer and are "blanketed" by the batch to insure that they are flushed into the mixer without the possibility of hanging up anywhere in the system. Accuracy in the weighing and handling of the smaller batch ingredients is a point that should not be neglected. It is interesting that Libbey-Owens-Ford now plans to put the batch weighing and mixing equipment under lock and key, so that this big batch plant will be deserted and will be in complete charge of one skilled operator at the central control desk.

Discussion—A short report by Fowler on the operation of the Libbey-Owens-Ford batch plant described by the author indicated the complete success of this automatic installation, both from the standpoint of accuracy and the elimination of the dust hazard. When the plant was started a slight puff of dust would be blown out when the mixed batch was dumped into the buckets, but even this has now been completely eliminated by means of by-pass pipes running from bottom to top of the containers.

Briquetting of Glass Batch. *By F. G. Schwalbe, Toledo Engineering Co., Inc.*

In an effort to eliminate batch plant dust, experiments with briquetted batch were made by the Ford Motor Co. as early as 1926 and in 1935 plans for briquetting batch to secure improved operation of a waste heat boiler and economizer were made. The use of briquettes has reduced the batch carry-over, increased the life of the checker brick and furnace upper structure and there is an apparent increase in life of the flux side walls resulting from a decrease in free alkali at the glass line. In Germany briquetted batch is made on standard brick pressing machines using water as a binder. In the Ford Motor glass plant, described in THE GLASS INDUSTRY for Dec., 1937, briquettes are made on a roll-type machine, using silicate of soda as a binder at Detroit and hydrated lime at St. Paul.

Ford briquettes are pillow-shaped and weigh 4 oz. each. They weigh approximately 120.75 lb. per cu. ft., and are 2 in. square by $1\frac{7}{16}$ thick. The pressure used in making the briquette is limited by the crushing strength of the sand. Briquettes are dried in transit to the tank hoppers by heat from the crown and, in the four-hour interval between briquetting and charging, the moisture content is reduced to 1.68 per cent by weight. Melting rate of the tank is increased by using briquettes, a 30 per cent increase being indicated.

The increase in melting rate reduces the fuel consumption per ton of glass, the following data being based on the use of 500-B.t.u. coke oven gas.

	Loose Batch	*Briquettes*
Output	75 tons	100 tons
Holding heat	90,000 cu.ft./hr.	90,000 cu.ft./hr.
Melting heat	20,620 " "	27,500 " "
Total heat	110,620 " "	117,500 " "
Fuel per ton of glass	35,398 cu. ft.	28,200 cu. ft.

These figures are for a plate glass tank. For a bottle tank the fuel per ton of glass would be 7,688 cu. ft., with loose batch and 6,975 cu. ft. with briquettes. The costs for producing silicate briquettes, per ton of glass, are as follows:

	Cullet Briquettes	*Cullet-free Briquettes*
Investment	$ .0331	$ .0266
Wet mix and briquetting power	.0250	.0200
Mixer paddles	.0020	.0013
Briquetting rolls	.2180	.1230
Silicate of soda	.5440	.4380
Labor	.1020	.0850
Total	$ .9241	$ .6939
Fuel saving	.8630	.8360
	Added cost— .0611	Saving— .1691

When hydrated lime is used as a binder it replaces some high calcium or dolomitic stone and effects a further saving in costs per ton as follows:

	Cullet Briquettes	*Cullet-free Briquettes*
Investment	$ .0331	$ .0226
Wet mix and briquetting power	.0250	.0200
Mixer paddles	.0020	.0013
Briquetting rolls	.2180	.1230
Hydrated lime	.2470	.2470
Labor	.1020	.0850
Total	$ .6271	$ .5029
Fuel saving	.8630	.8630
	Saving— .2359	Saving— .3601

These computations place no value to the credit of briquetting on prolonged life of the upper-structure refractories, decreased wear on the furnace lining, or cleaner checker chambers that operate at maximum efficiency throughout the life of the furnace.

Discussion—There were many questions regarding various details of the briquetting process, most of which were answered by reference to the paper itself. Samples of sodium silicate briquettes, both with and without cullet, and also of the hydrated lime briquettes were shown.

Batch Preparation and Handling in the Streator Factory, Owens-Illinois Glass Co. *By J. W. Wright. Owens-Illinois Glass Co.*

An example of changing conditions in the glass plant is found in the handling of incoming raw materials. The unloading of sand, soda ash and lime from box cars has been a troublesome job, even with the use of power shovels. Self-emptying cars offer the best solution to the problem, but a premium must be paid for their advantages. They offer the greatest benefit in the handling of soda ash and burned lime, both of which are irritating to the skin.

In the new batch plant at Streator new ideas were incorporated which appeared practical from the standpoint of better glass or improved working conditions. There are two rows of hollow-tile silos, five in each row, and each with a capacity of approximately 500 tons of sand or a proportional amount of other batch materials. Inner spaces between walls are used for smaller quantity materials and space is provided for the storage of cullet. Incoming raw materials are routed along the outside of the two rows of silos, two track hoppers being provided on each side. Each silo is vented by means of filters.

From the storage bins the materials pass through automatic weighing equipment onto a dust-tight collecting belt, thence to the mixer and finally into buckets, each of which holds one mixed batch. After receiving the batch charge, the bucket is raised automatically up an incline to a position on a monorail system. As the loaded bucket moves along, an empty bucket moves over and down the incline to receive its batch. A complete set of weighing equipment, collecting belts and mixer is provided for each row of silos, one set being used for flint and one for colored glasses. Decolorizer for flint glass, or coloring material for colored glass, is weighed into a container that is placed over the collecting belt and releases its load into the batch going to the mixer. Each individual bucket of mixed batch is marked with a tag indicating its destination, then connected in a train with four or five others, and finally moved by a traveling donkey on the monorail to a storage position near the tank. At the tanks the buckets are mechanically moved to a position over small hoppers which provide just enough batch for continuous feeding while the furnace attendant is removing an empty bucket and placing a filled bucket in position. Each bucket holds approximately 4,500 pounds of batch. Although the plant is nearly dust-proof, all operators are provided with respirators which are cleaned and sterilized daily. The cost of handling and mixing batch at Streator are slightly above costs in some other factories, but working conditions are of the best.

I. G. Fowler of Libbey-Owens-Ford registering. The registrators are Leland McLeish and Charles Wright, University of Illinois students.

Mold Design and Machine Operation. *By G. B. Langer, Lynch Corporation.*

While this paper is published in full on page 215 of this issue of THE GLASS INDUSTRY, there appears below some of the discussion of this interesting paper during the course of the Urbana conference.

Discussion—In answer to an inquiry by the author regarding attempts to secure working temperatures in molds, McLeod stated that he had tried to observe them and it was difficult, although of great importance. It was found, however, that chilled iron introduced many variables and the use of chills has been discontinued. McLeod also said that all molds in a set should be uniformly

J. L. Bacon and D. I. Dubois of Whitall Tatune scan their programs while waiting for the conference to begin.

homogeneous to avoid reworking by cut-and-try methods. Overmyer reported that chilled plungers do not dissipate heat as well as the unchilled type and, therefore, run hotter. Koeppen stressed the need for cooperative effort between mold makers, machine builders and operators to organize and correlate dependable data and to analyze matters which are now subject to greatly varying opinion, due to the fact that production requirements have gotten beyond technical developments. Garwood considered settle wave to be a machine problem and not a mold problem. In this respect the time between settle blow and counter blow is important and good results are secured by decreasing the time and holding the finish by special means. Berchtold mentioned tests on molds showing an average temperature of 950° F., and stated further some results on controlling settle wave by the small bubble process in which the cycle and the design of the parison were changed (IS machine). In a discussion about normalizing some confusion was caused by a difference in definition. Dixon mentioned that in normalizing, as understood by the foundryman, the casting is heated to about 900° and the result is simply a release of internal strain. He was also of the opinion that heating above the critical range changes the material to a softer structure and does not improve the casting for mold purposes. The meeting was, however, not in full agreement on this point.

Electric Melting of Glass. *By Y. R. Cornelius.*

This interesting paper on the operation of an electrically heated tank for the manufacture of sodium silicate, and the engineering and economics of commercial electric melting of glass, will be published in full in the July issue of THE GLASS INDUSTRY.

Development in Mold Irons. *By J. S. Vanick, International Nickel Co.*

The plain iron-base compositions and mixtures for glass mold castings have been varied up and down in carbon and silicon contents, often deliberately out of balance in the attempt to achieve improvements. During the experimental program glass molds moved from the chill-cast type of casting into progressively stronger and harder sand-cast types and, at this time, have completed the cycle, returning again to popularity the soft, chill-densened mold casting. Various mold iron compositions are listed in the following tables:

TABLE I

TYPICAL CHILL-CAST MOLD COMPOSITIONS

High Carbon Type—A		*Low Carbon Type—B*	
TC	3.50	TC	3.10
Si	2.30	Si	2.72
Tensile	21,000	Tensile	28,000
BHN	160	BHN	190

ALLOY CAST IRON TYPES

Type	*1*	*2*	*3*	*4*	*5*	*6*
TC	3.50	3.50	3.50	3.50	3.6-3.8	3.6-3.8
Si	2.30	2.30	2.00	2.00	1.4-1.6	1.4-1.6
Ni	0-15	.60	1.00-1.25	1.00-1.50	1.20-1.50	1.20-1.50
Cr	.30	.30	.30	None	——	None
Mo	None	None	None	None	None	.20-30
Cast	Chill	Chill	Chill	Chill	——	——
Annealed	Yes	Yes	Yes	Yes	Yes	Yes
Tensile*	22,000	24,000	28,000	26,000	36,000	35,000
BHN*	170	180	200	180	190	210

*Before annealing. Test bar values.

TABLE II

TYPICAL SAND-CAST MOLD COMPOSITIONS

	C	*D*	*E*
TC	2.75	3.20	3.60
Si	2.00	2.10	2.30
Mn	.60	.50	.50
Tensile*	50,000	33,000	20,000
BHN	250	190	160

Type	*10*	*11*	*12*	*13*	*14*
TC	3.70	3.10-3.40	3.10-3.40	3.00-3.20	2.70-2.90
Si	2.25	1.30-1.50	1.80-2.30	1.00-1.20	1.50-1.80
Mn	.58	.50- .60	.50- .60	.50- .70	.70- .90
Ni	1.85	1.25-1.50	.0- .50	1.40-1.60	1.50-2.00
Cr	None	.30- .60	.20- .30	.20- .30	None
Mo			.40- .60		
Cast	Chill	Chill	Chill	Chill	
Anneal	Yes	Yes	Yes	Yes	Yes
BHN*	174-184	220	210	220	220-240
Tensile*	24,000	38,000	35,000	40,000	55,000

*Before annealing. Test bar values.

In addition to being inexpensive, the essential requirements of mold irons are as follows:

1. Glass molds, whether of the press or blow types, must possess ability to be machined rapidly to a high finish. Such irons appear in the tables at A, 1, 2, 4, 5, and 10.

2. A structure conducive to the formation of a fine-grained, surface finish. All of the chill-cast and most of the sand-cast ones possess this characteristic.

3. Density or close grain throughout. Most of the alloys contribute toward graphite refinement.

4. A graphite particle population on the surface fine enough to prevent sticking. High-carbon, fine-grained irons take the lead, such as A, 1, 2, 4, and 5 of the chill series. The harder irons are subject to cracking and sticking.

5. A resistance to heat checking, leading to prevention of sticking. Annealing is helpful. Best irons are 5, 4 and 6 in the chill-cast group, with 2, 1 and A second. Nos. 10, 13, 11 and 12 follow for the sand-cast molds.

6. Resistance to deterioration by heat, leading to a fogging of the ware and requiring redressing. The high concentration of graphite in the softer chill-cast irons is helpful and these irons lend themselves better to mold shop cleaning operations.

7. Low thermal expansion. Reduction in silicon should be useful and manganese should be kept low. Chromium helps. Chill-cast irons 5 and 6 should be best, followed by 4, 3, 2 and 1, with 10 and 13 of the sand-cast series.

8. High thermal conductivity. Irons 6. 5 and 4 are first choice, with 3, 2 and 1 as second. In the sand-cast series, first 13 and 11, then 14 and 12.

9. Resistance to growth and scaling. Irons 5 and 6 should possess outstanding merit in the chill-cast series, while 2 and 3 would make good plunger compositions, possessing to greater hardness and less resistance to heat checking.

10. Resistance to wear, corrosion, contamination and staining. Chill-cast irons 1, 3 and 6 or sand-cast irons B, 14 and 13, are good examples.

Natural Laws Hurdle National Boundaries. *By Z. C. Kline, General Electric Co.*

This instructive and entertaining paper was based on thoughts engendered by the author's recent European trip. After remarking on the historic human proclivity to ascribe supernormal conditions to far distant places, Mr. Kline proceeded to describe and demonstrate various natural phenomena and their effect on the attitudes and characteristics of humanity. These included the force of gravitation and led up through other natural laws to a consideration of wave and vibration phenomena. Starting with sound waves the author branched into light phenomena, discussing finally the entire range of energy vibrations. The visible wave octave lies between the deep visible red having 400 million million vibrations per second and the deep visible violet having 800 million million vibrations per second. Gamma rays from radium B are 16 octaves above the visible octave and electric rays used in radio communication in 1920 are about 26 octaves below the visible. For illumination only the visible octave, or spectrum, is useful, but other rays can be converted into a wave length found in the visible spectrum. This is done by changing ultra-violet rays to a lower frequency, the process being to place especially prepared chemical compounds in their radiation. The use of such fluorescent powders in a new style of lamp was demonstrated.

A discussion of the author's European experiences was followed by the showing of slides illustrating many scenes visited and prominent European glass men met.

High Test Irons for the Glass Industry. *By F. W. Dixon, Jr., Gunite Foundries Corporation.*

By definition high-test cast iron has a tensile strength of over 40,000 lbs. per sq. in. and its production depends upon control of the method of melting as well as the analysis of the material. With a suitable analysis there must be strict metallurgical control to maintain uniformity and the melting operation must be conducted to produce the correct rate of solidification and graphitization when cast. Alloys are useful for producing certain results but are not necessary for securing iron with high tensile strength. Iron for glass moulds must be close-grained, not too hard for easy machining, but hard enough to resist battering and scratching, and it must be able to resist deterioration by hot glass. Density of high-test irons contributes to greater thermal conductivity and ability to dissipate heat. High-test, low-expansion irons also resist growth, which is probably the result of the penetration of hot gases into the material, forming bulky silica and ferric oxide and increasing the volume of the iron. Chromium and vanadium are also used to produce a growth-resistant iron.

Chromium is used to resist scaling at high temperatures and high-test iron wtih a high surface polish also resists the formation of scale and carbon. Heat checks are supposedly caused by a form of heat fatigue and this trouble is resisted by a low coefficient of expansion and a high elastic limit, both of which are properties of high-test irons. Although not essential, alloys are useful in the production of high-test irons with special properties. Nickel reduces chill, increases hardness and strength and produces a close-grained iron.

Chromium refines the grain, imparts hardness and resists growth and scaling. Molybdenum increases strength without hardness in moderate amounts and, in larger amounts, has a hardening action similar to nickel and chromium. Molybdenum also imparts toughness. Copper in proportions under 2 per cent increases both strength and hardness and is used with molybdenum. Vanadium hardens the metal, stabilizes the structure against heat, and is rarely used in amounts greater than .0025 per cent. Aluminum increases strength and refines the grain but adds difficulties in the form of frothy slag and blow holes.

Pattern equipment plays an important part in the production of castings with uniform soundness and freedom from defects. Gated metal patterns or mounted wooden patterns with gates in place are preferable. Proper patterns reduce mould shop losses and usually lower the casting price through a reduction in foundry labor. Design of the castings themselves is also important in securing best results from the foundry.

Concerning Colloidal Graphite and Its Utility in the Glass Industry. *By Raymond Szymanowitz, Acheson Industries, Inc.*

Manufactured, or synthetic, graphite produced in the electric furnace is chemically like the natural mineral but differs from it physically, having greater purity, less cohesiveness and a higher oxidation point. Devoid of abrasive impurities and resistant to oxidation, electric-furnace graphite has the necessary characteristics for a high-temperature lubricant in glass-making machinery. Powdered graphite does not have ready application to close-fitting mechanical parts, but colloidal graphite, manufactured by the process discovered by E. G. Acheson, remains with its liquid carrier under practically all

Discussion: Palmer presiding and Milner discussing.

conditions except evaporation, distillation and ultra-filtration. When evaporation of the carrier takes place, agglomeration of the particles results and yields a solid residue possessing the properties of non-colloidal material. Colloidal graphite suspensions in mineral oil and water are of most importance in the glass industry.

If an aqueous dispersion of graphite is applied by brushing, dipping or spraying, a film fo graphite remains upon evaporation of the carrier. Such dispersions are useful for lubricating glass-working tools, as a coating for paste moulds and for repairing scratches and imperfections in cast-iron moulds.

The film of graphite deposited on machine parts from an oil dispersion acts rather as a retainer for the oil than as a dry lubricant. The film of graphite is known as a "graphoid" surface. Although colloidal graphite is most effective under boundary conditions, it is common practice to employ it as a precautionary measure in mechanisms that must operate positively at all times, even though the loads be light and the oil film never in serious jeopardy.

Oils containing colloidal graphite are particularly useful for lubrication under high-temperature conditions, such as annealing car bearings, lehr chains and sprockets, incandescent lamp and vacuum tube machinery, cast-iron moulds, hinges, neck rings, screw pegs, etc. It is customary to use a light-bodied, low-carbon oil. In most cases the amount of colloidal graphite used in the oil-graphite mixture need not be more than 0.2 per cent by weight, but this may be varied for special cases, as may the type of oil used as a carrier.

"ILLINI CERAMIST" APPEARS

The Illini Ceramist makes its bow this month. Published by the students of the Ceramic Engineering Department, it is the only departmental year book to appear on the campus of the University of Illinois. The year book is six by nine in size, attractively bound with a blue and orange cover, and contains 40 pages of facts and photos depicting ceramics and ceramists at the University.

This second (1938) edition is dedicated to Ross C. Purdy, "First Instructor at the Department of Ceramic Engineering, General Secretary of the American Ceramic Society and Creator of its present structure, Editor of the Publications of the American Ceramic Society, Author of Many Valuable Contributions to Ceramic Literature, a Leader in Research for the Industry."

Two very appropriate and informative articles have been contributed by Professor Cullen W. Parmelee on "Ceramic Education" and "The Ceramic Industry." Here the author attempts very successfully to give the student an insight into ceramics, particularly from a vocational standpoint, and suggests the qualifications and preparation necessary for one to succeed in this industry. Sections of the year book are devoted to the staff, graduate and undergraduate, individuals and activities.

The Illini Ceramist is the work of an executive staff, composed of Warren R. Johnson, editor; Leland J. McCleish, business manager; and J. Tarre, photo editor. It reflects great credit upon these gentlemen.

• On April 23, 1938, the general offices of the United States Glass Co. were moved from Pittsburgh to the Tiffin, Ohio, plant.

GLASS DIVISION FALL MEETING

The Glass Division of the American Ceramic Society will hold its 10th fall meeting at the Chamberlin Hotel, Old Point Comfort, Va., Sept. 9-12. The members of the committee in charge of arrangements are W. R. Lester, chairman, F. C. Flint and S. R. Scholes.

A tentative program for the meeting has been planned as follows:

Friday, Sept. 9. Leave Baltimore at 6:30 P. M., E. S. T., for Old Point Comfort via Old Bay Line steamer.

Saturday, Sept. 10. Arrive Old Point Comfort for an early breakfast. Meeting 9:30 A. M. to 12:30 P. M. Papers: To be announced later (Time for about 3 papers). Golf, swimming and Williamsburg trip. Informal banquet followed by dancing on the Marine Roof.

Sunday, Sept. 11. Chemical Analysis Round-Table Discussion, 10:30 A. M. to 12:00 M. Golf, swimming, lounging. Leave Old Point Comfort 7:30 P. M., E. S. T., for Baltimore via Old Bay Line.

Monday, Sept. 12. Arrive in Baltimore 6:30 A. M. Breakfast on boat (occupancy until 8:30 A. M., E. S. T.).

Rates include round-trip transportation, Baltimore to Old Point Comfort via Old Bay Line steamer, meals, stateroom, and hotel room. Rates are quoted on double occupancy at the hotel. If single occupancy at the hotel is desired, add $1.00 to rates quoted below:

	Steamer Accommodations	*Single Oc'p'cy*	*Double Oc'p'cy*
$1.75	Outside upper and lower berthroom	$17.50	$15.75
2.25	Outside upper and lower berthroom with shower or toilet	18.50	16.25
2.75	Outside upper and lower berthroom with tub bath and toilet	19.50	16.75
3.00	Outside double bedroom	20.00	17.00
3.25	Outside double bedroom with toilet	20.50	17.25
3.50	Outside double bedroom wtih toilet	21.00	17.50
4.00	Outside double bedroom with tub bath and toilet or shower bath and toilet	22.00	18.00
4.00	Outside bedroom—double bed and single bed with toilet	....	18.00
4.25	Outside double bedroom with tub bath and toilet	22.50	18.25
4.50	Outside twin bedroom with tub bath and toilet	23.00	18.50

Note: For those driving their own cars to Baltimore a "call for and deliver" garage service is available at the cost of 50 cents per night.

The trip to historic Williamsburg and Yorktown can be arranged at a price of $3.15 per person if there are at least 25 in the group. This price covers bus fare, lunch and admission to the buildings at Williamsburg. The greens fee for golf at the Chamberlin Country Club will be $1.00 a day.

PILKINGTON ACQUIRES PHILLIPS

One of the largest industrial commercial deals of recent years in Canada has been completed with the purchase by Pilkington Brothers (Canada), British glass manufacturers and distributors, of the operating assets of the W. E. Phillips Co., Oshawa, Ont. The amount involved is reported to have been close to $1,000,000. The plant and distribution facilities thus acquired are being operated by a new firm, W. E. Phillips Glass Co., formed by Pilkington's. The original company will continue under the direction of Col. W. E. Phillips as a holding company for its substantial investment interest in Duplate Safety Glass Co. of Canada and its subsidiaries, Duplate (Windsor), Ltd., and H. G. McIntyre, Ltd., of Claremont, Canada.

PRODUCTON FIGURES FOR THE GLASS INDUSTRY DURING APRIL

Plate Glass—The total production of polished plate glass by member companies of the Plate Glass Manufacturers of America during April, 1938, was 3,819,735 sq. ft., as compared to 3,802,112 sq. ft. produced by the same companies in March, and 21,955,771 sq. ft. produced in the corresponding month last year, April 1937.

Window Glass—Window glass production during April 1938 was 341,014 boxes, which represents 21 per cent of industry capacity. As compared with this, April 1937 production was 1,330,893 boxes, representing 81.9 per cent of industry capacity.

Glass Containers—Production of glass containers during the month of April was 3,647,088 gross bringing the 1938 total to 13,393,730 gross. Shipments during April were 3,645,253 gross and 13,137,731 gross so far during the first four months of 1938.

IMPORTS QUARTZ CRYSTALS

The Bausch & Lomb Optical Co. reports that they have recently imported one of the largest and finest quartz crystals ever to enter the United States. Coming from the Province of Minas Geraes in Brazil, where it was brought by mule pack from the diamond section of the Serra de Mantequeira range, 1,500 miles from the coast, the huge crystal weighs 63 pounds and costs $18.00 per pound. Based on optical quality, experts believe that it surpasses any museum piece of this type in the country.

Although quartz, a form of silica occurring in hexagonal crystals, is distributed throughout the world, Bausch & Lomb states that no deposits of suitable quality have been found in the United States, and therefore goes to Brazil for its chief source of supply. Fred C. Brueck, who has studied optical minerals for 25 years, says:

"There are two different crystals in this one block. One piece has a right-handed movement like a clock, while the other has a counter-clockwise movement. The interpenetration here is but partial and the twin has the appearance of a mirror-image or reflection twin."

Bausch & Lomb state that they use quartz crystals for lenses and prisms because of their high transparency and superior resolution obtained with this material in the shorter wave lengths of light, such as the ultraviolet.

THE LADIES GO GLASSY

For the occasion of the 1939 Golden Gate International Exposition, the ladies of the Yerba Buena Club, the official hospitality club, have decided to build themselves a club house of glass. It will occupy 33,390 square feet and will overlook a spacious lagoon. While some wood will be used in the construction, glass will be the principal material to emphasize the effect of "outdoorness" amidst beautiful garden surroundings.

GLASSMEN HONORED AT MUNCIE

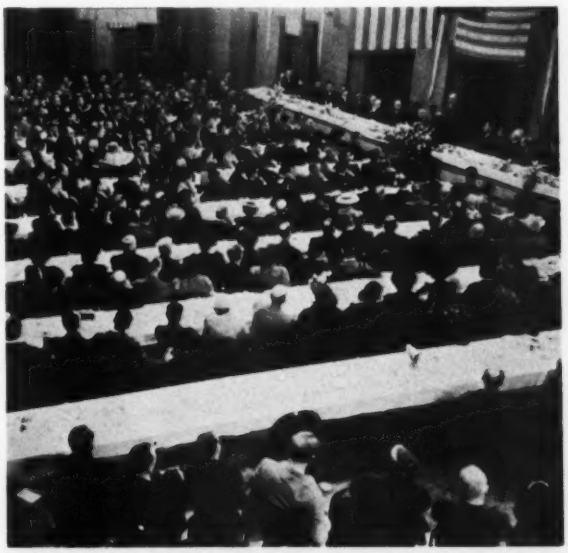
More than four hundred people paid tribute to the glass industries of Central Eastern Indiana at a banquet given March 18 by the Chamber of Commerce of Muncie. Particular honor was paid to three glassmen for long years of faithful service.

Harry A. McDonald holds the longest service record of employment among present day employees in the glass industry of that district, with 69 years to his credit. He entered the employ of the Hemingway Glass Co. at Covington, Ky., in 1869 as a carry-in boy, and moved to Muncie with the company in 1888. He is now employed by the Hemingway Division of the Owens-Illinois Glass Co.

Michael M. Menard has been employed by Ball Brothers Co. since February 1, 1887, when he started work as a glass gatherer. In all that time, he left the company only twice; once for a three-month period and at another time for four months.

Elza DeWitt holds the record for the longest continuous service record of employment with one company, 49 years. He started with Ball Brothers at Muncie on March 12, 1889 as a helper on pot furnaces and has never received a pay check from any other company in his entire life.

The accompanying illustration taken at the banquet shows many well-known glassmen at the speakers table, including E. Arthur Ball, treasurer of Ball Brothers Co; W. J. Mathews, manager of the Sterling Glass Co., Lapel; Harry McDonald, assistant treasurer, Hart Glass Co; Carl H. Smith, plant manager, Owens-Illinois Glass Co., I & S Products Division; F. L. Paul, vice-president and general manager, Canton Glass Co; Charles O. Grafton, general manager, Gill Clay Pot Co; Thomas Collins, manager, Owens-Illinois Glass Co., Gas City; Charles L. Gaunt, president, Indiana Glass Co; Frank C. Ball, president, Ball Brothers Co; J. M. Foster, president, Foster-Forbes Glass Co; T. C. Werbe, president, Lynch Corporation; J. B. Hayes, chairman, Alton Plant Management Committee, Owens-Illinois Glass Co; C. P. Overmyer, president, Overmyer Mould Co; Paul Hershfield, general factories manager, Anchor-Hocking Glass Corp; Joseph Bartulis, assistant personnel director, Owens-Illinois Glass Co; J. C. Schwab, plant manager, Anchor-Hocking Glass Corp., Winchester; Elza DeWitt, Ball Brothers Co; Michel M. Menard, Ball Brothers Co; and Harry A. McDonald, Owens-Illinois Glass Co.



Annual Spring Dinner meeting of the Muncie Chamber of Commerce, which paid tribute to the glass industries.

GLASS RESEARCH INSTITUTE IN CZECHOSLOVAKIA

By DR. ING. VACLAV CTYROKY

The Czechoslovak glass industry originated in the 14th century. Its growth was rapid and by the 16th century there were 44 glass works in Bohemia. The invention of crystal glass ("Crystal de Bohême") during this period brought renown to the country and developed the artistic abilities of thousands of workers. Artisans in the Gablong Section in northwest Bohemia gave their skill to the manufacture of elegant trinkets or "bijouterie," an unique industry which began during the Napoleonic wars and is still thriving. Today, in Czechoslovakia, 150,000 workers are employed in about 140 glassworks; the value of exports of glass products is surpassed by no other nation except Germany.

The rise of Czechoslovakian glass progressed hand in hand with the skill of its individual craftsmen. Modern conditions, however, have created new conditions calling for extensive research and development work. Accordingly, a Glass Research Institute has been established in the little town of Hradec Králové, as an annex to the Chamber of Commerce. This laboratory is the center of the glass technological researches in Czechoslovakia and from here the organization and publicity of the industry are directed.

The Institute is managed by a council of which F. Ulrich is President and whose members represent all sections of the industry. The Director is V. Ctyroky and his scientific collaborators are O. Pridal, M. Fanderlik, and Z. Schaefer. Other investigators connected with the glass industry work in the Institute periodically.

The building itself is a fine example of glass in architecture, the glass, of course, being products of the home industry. The interior halls contain fine examples of glass artistry.

The research departments consist of technological, chemical, physical, photographic and photometric laboratories, a small-scale glass plant, and a colorimetric laboratory. These laboratories are equipped with such modern scientific apparatus as is necessary for theoretical and practical studies on glass.

The technological laboratories are equipped with small-scale glass melting and annealing equipment, with machines for the determination of mechanical constants; as elasitcity, bending and impact tests; with grinding, polishing, and cutting machines; with equipment for testing raw materials, including colorizers and decolorizers. Other apparatus is used to study various technological operations.

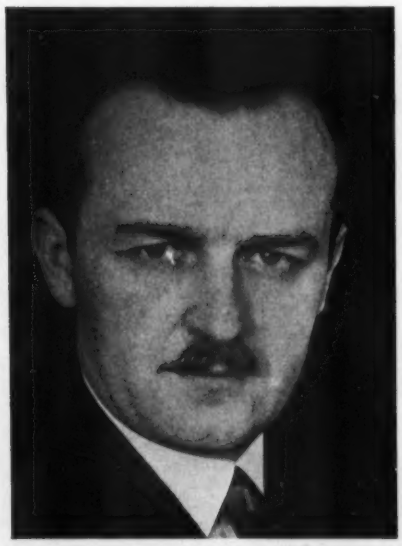
The chemical laboratories are equipped with apparatus for obtaining qualitative and quantitative analyses of raw materials, glasses and other substances used in glass manufacture.

The physical laboratories contain a spectrophotometer, refractometer, polarimeters, thermal expansion apparatus, polarizing microscopes, a quartz-spectrograph, potentiometers, equipment for examination of striae.

The photographic laboratory and dark room is used to process the photomicrographs and spectrograms. Other equipment includes motion-picture cameras and projection apparatus. Transmission of light is studied in the photometric laboratory.

A heat laboratory and small-scale glass plant provide facilities for making experimental metals of glasses. The glass plant is equipped with a regenerative furnace holding four pots with a melting capacity of 500 lbs. of glass per day, as well as a recuperative two-pot furnace, an annealing lehr, a gas producer, and another small two-pot furnace.

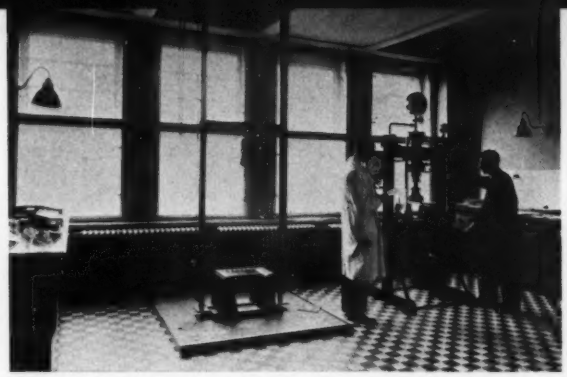
With the above equipment it is possible to make chem-



Dr. Ing. Václav Ctyroky, director of the Glass Research Institute at Hradec Králové, Czechoslovakia.

The Glass Research Institute at Hradec Králové, Czechoslovakia. The building's front made of white and green opaque glass. The small-scale glass plant is in background.

The Technological Laboratory with cutting, grinding, and polishing machines.



The Technological Laboratory showing equipment for determining the strength of glass.

The Technological Laboratory and melting furnaces (gas and electric).

The Technological Laboratory showing another view of the melting furnaces.

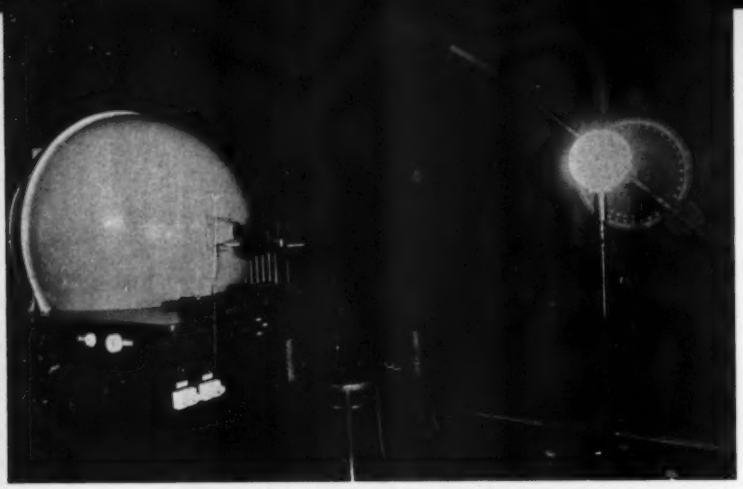
ical analyses of all materials used in the glass industry and also a great variety of physical and mechanical tests as elasticity, bending strength, tests on toughened glasses, eye-protection glasses, opal glasses, etc.

The Institute certifies to the efficiency of lighting bodies, the quality or defects of glass products; makes determinations of specific gravity, index of refraction, dispersion, thermal expansion, internal strains and annealing, transmission of light of various wave lengths by colored glasses, transmission of ultraviolet and infrared, fluorescence phenomena in glass for modern discharge tubes, glass homogenity, potentiometric testing of the durability of glasses, formation of schedules for rational annealing, softening temperature, examination of stones, striae, and other defects, the testing of coal for gas producers, etc.

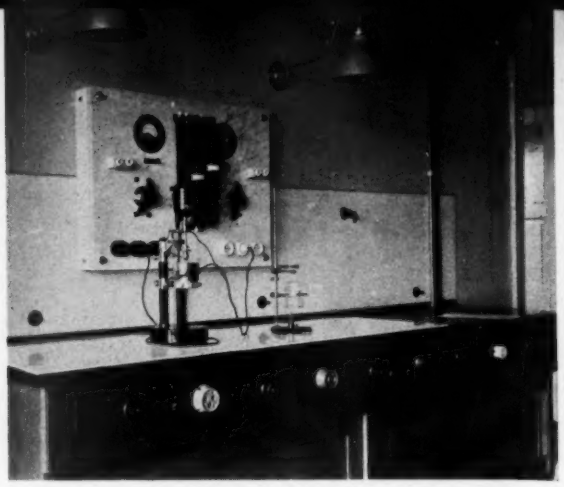
As examples of work carried out in the Institute, the following is typical: A systematic study of the Czechoslovakian laboratory glassware. The study of grinding materials used in the glass industry. A study concerning laminated and toughened safety glasses. A study of the Czechoslovak glass melting sands. The study of

Chemical laboratory.

Physical laboratory.



Photometric laboratory in the Glass Research Institute at Hradec Králové.



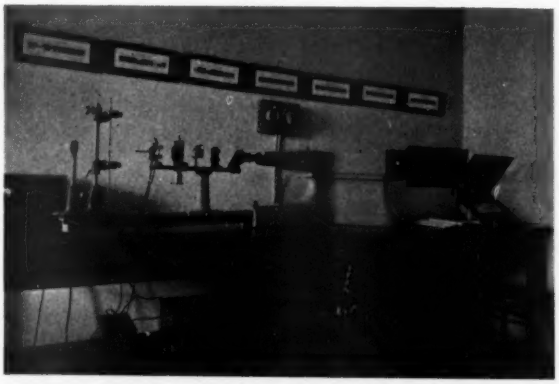
Electro-analysis in the Glass Research Institute at Hradec Králové.

glass wall tile. Chemical analytical methods, particularly for glass analyses. The study of colored glasses for railway signals, and formation of standards for the Czechoslovakian railways. The study of lead glasses for the manufacture of imitation gems. The testing of insulating properties of thermos bottles. The study of methods for testing and judging light-diffusing glasses. The study of heat-transmission of colored glasses and special heat-absorbing glasses. The study of annealing of glass bricks. The determination of the homogeneity of flat glass with respect to mechanical strength. The study of internal stresses in glass and the formation of an exact method for measuring stresses. The study and manufacture of new eye-protective glasses for welding.

The small-scale glass plant was used to determine the possibility of using new kinds of coal in gas-producers, such as the black coal of Kladno, brown coal of Radonice, brown coal briquettes, and tar. Some studies on electric melting of glass have been made.

The Glass Research Institute publishes its periodical, "Sklárské Rozhledy," which is the official organ of the Czechoslovakian glass industry. It contains news of the Institute, papers, and information concerning the progress of the glass industry. The Institute publishes informative books concerning glass technology and various methods of decoration.

Besides the research and testing activities mentioned, the Institute is occupied also with propaganda and organization, with the expositions of the Czechoslovakian glass industry and occasionally with international expositions. It organizes various courses as the manufacture of mirrors, glass etching, joining of glass by lead, sewing with glass pearls, the manufacture of ornaments for Christmas trees, the use of glass wall tile. It introduces new articles, such as glass ornaments for Christmas trees, special glasses for pharmaceutical purposes, etc.



Quartz-spectrograph in the Glass Research Institute at Hradec Králové.

Small-scale glass plant in the Glass Research Institute at Hradec Králové. Four-pot melting furnace. The annealing lehr and gas producer's equipment in background.

The course-room in the Glass Research Institute in Hradec Králové. The home-workers are learning the manufacture of glass ornaments for Christmas trees in a special course arranged by the Institute.

The home-workers are learning the painting of glass ornaments for Christmas trees in special course arranged by the Institute.

GLASS NEWS FROM ABROAD

China—In view* of the apparent desire of a number of Japanese petty industrialists to start glass manufacture in North China the Japanese military authorities have hinted that they will not allow an influx of "incompetent adventurers." Although it is not contemplated to place glass manufacture under the control of the North China Industrial Development Co., the Japanese "national-policy" concern, it is believed in some quarters that the attitude of the authorities indicates a desire to have the glass industry monopolized by a single firm, possibly the Chingwangtao Glass Co.

Germany—As a result of perfected manufacturing processes and the opening of new and promising fields of application, Germany's production of glass wool has expanded materially in recent times, according to a report from the U. S. Department of Commerce. Output currently amounts to between 7,000 and 8,000 metric tons annually and is expected to increase as time goes on.

India—The Interim Ministry in the United Provinces proposes to spend 29,000 rupees ($10,730) for developing the glass industry in that province. The proposed scheme provides for a foreign glass technologist to be appointed to study the industry in general, with headquarters at the Benares Hindu University. At present the glass industry in the United Provinces is said to be in a rather primitive state.

Japan—According to the Japan Mirror Export Trade Industrial Association, exports of mirrors in 1937 recorded an increase over the preceding year, the aggregate turnover totaling 4,200,500 yen (approximately $1,200,000). Authorities of the association confidently predict that within a short time exports of mirrors will top the 10,000,000-yen mark. Exports to principal destinations were as follows:

Destination	*Quantity (Dozen)*	*Value (Yen)*
India	2,710,000	1,210,000
Africa	1,180,000	530,000
South Sea Islands	840,000	380,000
Australia	180,000	230,000
England	200,000	120,000
North America	760,000	500,000
Manchukuo	710,000	550,000
China	150,000	100,000

The Asahi Glass Co. have recently put on the market several types of safety glass, including an organic synthetic glass, on which they have done considerable research work. Asahi is also expanding its business in the field of by-products with particular emphasis on soda ash. The company has been most active in Manchuria, having obtained complete control of the Manchuria Soda Co. and the Shoko Glass Co., which will start operations in their plate plant this summer utilizing the Fourcault process. In China, Asahi, in addition to taking over the Yaohua Glass Works, Chingwangtao, has absorbed the Yung Li Soda Co., the largest unit in the field.

Because of the difficulties in importing quartz glass under the rigid exchange control act, the demand for the domestic product has increased considerably and the Japan Quartz Glass Co. has raised its capital from 150,000 to 500,000 yen to increase production facilities to meet the demand.

Convinced of the industrial possibilities of the process for the manufacture of lens blocs which has been developed by the Institute for Physical and Chemical Research, the Riken Optical Industry Co. has been formed, with a capital of 5,000,000 yen, to specialize in the manufacture of high-grade optical glass for cameras and instruments.

Norway—According to the U. S. Department of Commerce there were five glass works in Norway in 1935 employing approximately 855 persons and producing glass products valued at Kr. 5,141,624 (approximately $1,000,000). Almost an equal amount, Kr. 4,679,734, was imported while only Kr. 56,950 was exported that year. However, there appears to be little opportunity for American manufacturers of glass to obtain an important share of this market. Local production of bottles, preserving jars, window glass and table glassware is protected by a high tariff, and is adequate for local consumption. American producers of plate glass, lamp shades and globes, cut glass and other glassware have to date been unable to compete on a price basis with German, Belgian and Czech producers. Safety glass for automobiles is at present one of the principal imports from the United States, but since the assembly of autos in Norway is decidedly limited, this market is not important.

Poland—Increased consumption of glass products by various domestic industries, particularly the building trades and beverage manufacturers, resulted in substantial improvement during 1936. Production, sales and employment registered increases. Although exports declined, the average value per kilo increased due to exports of high quality glass, chiefly to Britain. The number of glass works in operation during 1936 was 64.

Portugal—Under the provisions of Government Decree No. 28,236, no new hand-operated glass factories may be established in Portugal and those now operated manually are to be closed down as soon as their laborers can be absorbed by mechanized factories, or retired. At present there are seven factories manufacturing sheet glass, six of which have already requested authorization from the government for the installation of machinery and have organized themselves into two corporations. The government is understood to have promulgated the present regulations because of the inability of the industry to operate economically.

The Tsurumi, Japan, plant of the large Asahi Glass Co.

*The source of this information is the Japan Trade News & Photo Service.

BOOK REVIEWS

Glass in Modern Construction. This book is primarily a collection of photographs, with a brief comment on each from the point of view, usually, of the artist, but with an eye to the practical purpose accomplished. The figures are occasionally helped out by "details" (drawings of construction details) or actual plans. More of the latter would not be amiss. There is also an introductory text which gives some account of the history of glass, firstly as a material of the craftsman, and secondly as an architectural medium. It is the reviewer's understanding that the supposed Egyptian glass blowers of 2000 B.C. in the old tomb paintings are not blowing glass at all, and that this is generally conceded.

Otherwise this part of the text is substantially correct, though it contains nothing new. The text continues however with a discussion of flat glass (including mirrors) and such structural glasses as we have, which is much less commonplace, and should be of value to architects. In fact the text part of the book is probably the most valuable part, and might be greatly expanded with advantage.

The collection of photographs occupying the bulk of the book is severely restricted in two directions; geographically, by being confined to the United States; and historically, by being confined to the last year to two. Many of the most striking examples of modernistic glass architecture are to be found in Europe (particularly continental Europe), and in South America. And if the text reviews windows and ornamentation historically, it would illustrate the subject better if the photographs followed the same plan.

This book is very beautifully printed, and the photography is often fine—better as a matter of art than the objects it depicts. We notice, in reference to Plate 23, that the authors do not know what is meant by refractive index, and use the term as synoymous with scattering or diffusing ability. We notice also that though the book is published and printed in America, the spelling of "coloured" is always in the English version.

Turning for a moment now from the book to the subject of which it treats, it is obvious to one brought up in the richer fields of masonry, wood, and steel construction, that glass as a constructional material is either in its infancy or is by nature a moron. The paucity of available glass forms that can be classed as structural results is a very limited architecture. The book shows that architects are groping for a method of using such glass forms as are available, and are being limited very severely by lack of enterprise on the part of glass manufacturers. If steel or masonry were available in as few forms, we should still be living in turf houses and building wooden bridges.

The architects are evidently interested in using glass if they can get it, but the glass manufacturers are still under the impression that glass is something to put beer in, and their principal preoccupation is to see that they are not put out of business by tin cans or goat skins. The flat glass manufacturers for many years have been even less progressive than the container makers; they have been spoiled by easy money from the automobile industry, and are hardly aware of the existence of any United States outside Detroit. F.W.P.

Colorimetric Methods of Analysis, by Foster D. and Cornelia T. Snell. Vol. I; Inorganic.

This second edition of Snell's work includes also a volume dealing with organic and biological color tests. But of particular interest to analysts of glasses, raw materials, and colorants is this first volume, which is a fine compendium of the best-known methods for the colorimetric estimation of more than fifty elements.

The first hundred pages are given to thorough and complete discussion of the theories and laws of colorimetry, methods of calculation, apparatus, development of standards, the use of liquid and solid standards, dilution and duplication methods, and the application of various types of colorimeters. The final chapter of this introductory group enters fully into the accuracy of colorimetric methods, and points out the sources of error.

A number of the methods find direct application in the analysis of glasses and of raw materials for glassmaking, particularly when it becomes desirable to detect relatively small amounts of various elements. The advantage of these methods lies not only in the rapidity with which the determinations can be made, but in the accuracy for small quantities, which far exceeds the accuracy of any gravimetric method. Copper, for example, may be found if present to the extent of one part in five million.

A number of methods are given for the estimation of lead; although in glasses, this element is usually present, if at all, in quantities easily estimated by other means. Arsenic receives a good deal of attention, because of its importance as a potential poison. Certain modifications of the Gutzeit method are sensitive to as little as 0.0002 mg. of arsenious oxide.

A number of methods are given for the estimation of iron, supplying a range of choice for the analyst who wishes to estimate this omnipresent impurity in glasses. As in the directions for all the methods, a great deal of attention is paid to interferences and their elimination, especially in the very important thiocyanate estimation. Nickel, cobalt, and manganese are also adequately handled.

Colorimetric methods are given for a number of substances such as alumina, the alkalies, calcium, magnesium and silica, which would not be particularly useful because of the adequacy of gravimetric determinations. On the other hand, we could wish that more hopeful colorimetric methods were given for boron, although some prospect is presented that the turmeric test may reach quantitative development.

Among the acid radicals fluorine, for which several methods are given, is of particular interest.

The book is very thoroughly indexed, both by subjects and authors; and footnotes appear, citing the original references for each method described. The treatment is frankly critical; and the reader is assisted in discriminating between methods as to reliability by the extended comment of the authors on relative accuracies. The authors are to be congratulated upon having brought this splendid reference work up to date by the examination and inclusion of methods which have appeared since the first edition (1921). This is a work which every analytical chemist will want for his reference library. S.R.S.

EQUIPMENT AND SUPPLIES

WILSON NO. 750 DUST RESPIRATOR

Wilson Products, Inc., 346 Thorn St., Reading, Pa., has recently placed on the market a new, dual-disc respirator for protection against Type A, or nuisance, dusts. Developed in the Industrial Hygiene Laboratory of the company, the new respirator has been designated No. 750 and bears approval No. 2119 of the United States Bureau of Mines.

This respirator employs inexpensive, throw-away discs and such inexpensive filters are essential in many occupations particularly wet operations. Only one filter is needed for each holder and either side of the filter may face outwardly, so the wearer has no difficulty in making filter changes and has assured protection, according to the manufacturer. The dual-disc filters provide 28 square inches of filtering surface, thus giving small resistance to breathing.

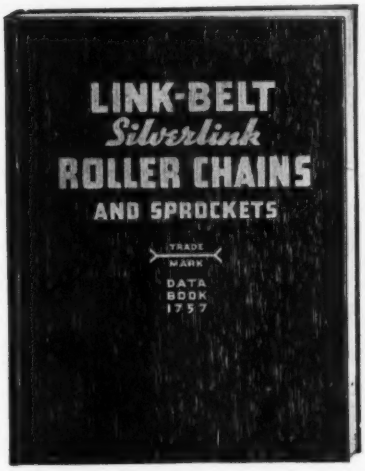
UNIVERSAL pH INDICATOR

The universal pH indicator recently placed on the market by Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa., reads directly in pH with glass, quinhydrone, hydrogen or any other electrode following the Nernst equation. When used with the glass electrode system furnished, a simple setting of the temperature compensator dial adapts the entire pH scale to measurements at that temperature. This also applies if a quinhydrone electrode is substituted for the glass electrode.

Also equipped with a voltage scale, the instrument can be used in oxidation-reduction potential measurements and in current and resistance determinations. Only a 5 ml. sample is required for measurement and everything nceessary for glass electrode measurements is included with the instrument. Other features include quartz insulation, where necessary, a separate battery compartment to prevent corrosion, accuracy in atmospheres of up to 95 per cent relative humidity and ability to make sodium correction, when necessary, directly in pH units. Catalog E-96 (1) illustrates and describes the instrument.

BULLETINS RECEIVED

Link-Belt Company, 307 N. Michigan Ave., Chicago, Ill., announces a new data book, No. 1757, devoted to its Silverlink roller chain and sprockets and including 174 pages of practical information, application pictures and engineering data. Twenty-two pages of the book contain tabulations and uses

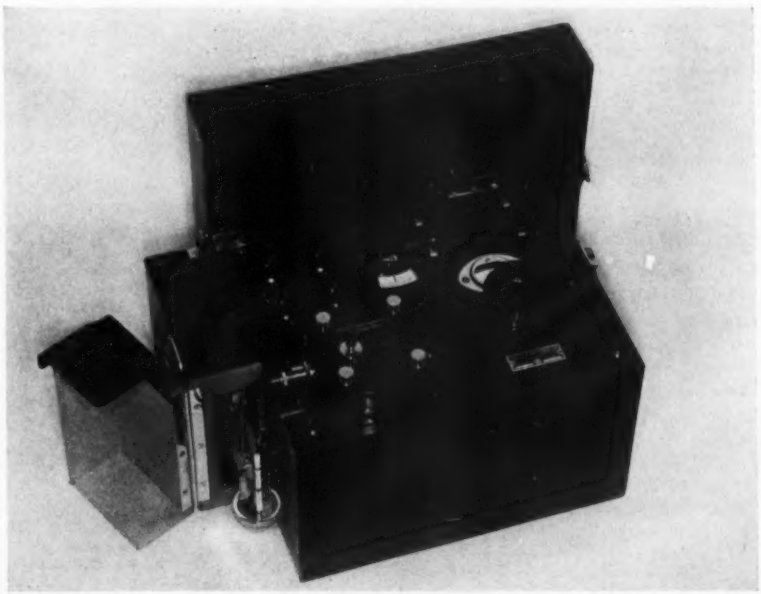


of Silverlink chain on conveyor work, including the steel "flat-top" design for the handling of bottles, jars and similar containers. Other products covered include the line of stainless steel and bronze chains, roller-chain flexible couplings and standard and made-to-order sprocket wheels. The concluding pages of the book contain power formulae for chain conveyors and elevators, horsepower tables, electrical data and other engineering information.

Ransome Concrete Machinery Co., Dunellen, N. J. A new 20-page bulletin, entitled Ransome Industrial Mixers, features many new types of dustproof mixers for the chemical, fertilizer and glass industries. The booklet is profusely illustrated with pictures of all types of Ransome equipment with diagrams of mixing actions and includes tables of capacities and dimensions.

Mathews Conveyer Co., 196 Tenth St., Elwood City, Pa. An attractive 32-page booklet in two colors illustrates and describes the variety of conveying equipment manufactured by this company. Seventeen types of conveyers, chutes, elevators and hoists, together with their uses, are first covered concisely and the remainder of the book is devoted to further exposition of the various types. Fine application pictures of all types, in use in a great variety of industries, are used to illustrate the details of design and operation.

The Elwell-Parker Electric Co., Cleveland, Ohio. Two new bulletins show the Type F-8 Tiering Fork Truck and the Type E-2 High-Lift Platform Truck.



CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	43.00	46.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$)	lb.	....	....
Granulated	In bags, lb.	.021	.026-.0286
Powdered	In bags, lb.	.0235	.0286-.036
Boric acid (H_3BO_3) granulated	In bags, lb.	.0475	.0531-.0556
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith)	lb.	.0875	.0925
Synthetic (Artificial)	lb.	.0875	.0925
Feldspar—			
20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	30.00	....
In bags	ton	31.60	38.00-40.60
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.07	....
In 5 Ton lots	lb.	....	.075
Less than 5 Tons	lb.	....	.08
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	10.50	....
Burnt (CaO) ground, in bulk	ton	7.00	....
Burnt, ground, in paper sacks	ton	9.00	....
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.25	2.25
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.065	.0675
Hydrated 80-85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4)	ton	15.50	27.00
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb.	.95	....
In barrels	Per 100 lb.	1.35	....
In bags	Per 100 lb.	1.10	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	Per 100 lb.	....	2.50-2.90
95% and 97%			
Bulk	Per 100 lb.	1.35	....
200 lb. bags		1.415	1.44
100 lb. bags		1.45	1.475

Special Materials

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	....	.03½
Aluminum oxide (Al_2O_3)	lb.	.04	.05
Antimony oxide (Sb_2O_3)	lb.	.12	.12½
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.0225	.03½
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	.07¾
Lepidolite—			
Nepheline syenite—			
Pyrophyllite, Standard Grade	lb.	9.00	12.00
Rutile (TiO_2) powdered, 95%	lb.	.11-.12	.13-.15
Sodium fluosilicate (Na_2SiF_6)	lb.	.05	.05½
Tin Oxide (SnO_2) in bbls.	lb.	....	.44
Zinc Oxide (ZnO)			
American process, Bags	lb.	.06¼	.06½
White Seal, 150 lb. bbls.	lb.	.08¾	.09
Green Seal bags	lb.	.08	.08¼
Domestic White Seal bags	lb.	.08½	.08¾
Red Seal, bags	lb.	.07½	.07¾
Zircon			
Refined Granular (Milled .01-.02c higher)		.06½	.07-.08
Commercial, Gran. (Milled .02¼-.02½ higher)		.02¾	.03-.03½

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	....	1.50-1.75
(Commercial, 25% Selenium)	lb.	....	.90
Cadmium oxide—			
Cadmium sulphide (CdS)	lb.	....	1.10-1.20
Chromite (99% through 200 mesh)	lb.	37.00	40.00
Cerium hydrate—			
100 lb. drums and 600 lb. barrels	lb.	....	.60
Cerium oxide—			
Chrome Oxide Green, 400 lb. bbls.	lb.	....	.22-.26
Cobalt oxide (Co_3O_4)			
In bbls. 350 lbs. or more,	lb.	....	1.67
Less than 350 lbs.,	lb.	....	1.77
Copper oxide—			
Red (Cu_2O)	lb.	....	.20¼
Black (CuO)	lb.	....	.15-.17½
Black prepared	lb.	....	.22
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.0425
Black (Fe_3O_4)	lb.	.04½	....
Iron Chromate	lb.	....	.035-.05
Lead Chromate ($PbCrO_4$)	lb.	....	.16
Manganese, Black Oxide			
In Paper bags	ton	57.50	60.50-65.50
In Burlap bags	ton	59.50	62.50-67.50
In Casks	ton	61.50	64.50-69.50
Neodymium oxalate, 50 lb. drums	lb.	....	3.50
Nickel oxide (Ni_2O_3), black	lb.	....	.35-.40
Nickel monoxide (NiO), green	lb.	....	.35-.40
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.03¾	.09
Powdered	lb.	....	.0975
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	....	.27
Powder blue	lb.	....	.2075-.2125
Rare earth hydrate—			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) In 100 lb. lots	lb.	....	2.00
In lesser quantities	lb.	....	2.10
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06¾	.07
Sodium chromate (Na_2CrO_4) Anhydrous	lb.	.08¼	.08½
Sodium selenite (Na_2SeO_3)	lb.	....	1.80-2.00
Sodium uranate (Na_2UO_4) Orange	lb.	....	1.50-1.55
Yellow	lb.	....	1.50-1.55
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls.	Per 100 lb.	2.90	3.25-3.65
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	....	2.25
Yellow orange	lb.	....	1.50

Polishing Materials

		Carlots	Less Carlots
Emery, Turkish	lb.	....	.07
Pumice Stone,			
American Ground Italian FFF, FF, F	lb.	....	.03
0, 0½, ½, 1.	lb.	....	.03¾
Putty Powder	lb.	....	.38-.42
Rotten Stone	lb.	....	.03
Rouge, Red	lb.	....	.14
Black	lb.	....	.16

TUF-FLEX ENTERS NEW FIELDS

By using panes of heat-strengthened plate glass the Chicago Boiler Co. recently constructed a steel vacuum chamber to test performance of airplane radio apparatus at extremely high altitudes; in this case measuring atmospheric conditions equivalent to 67,000 feet altitude. When the chamber was completely evacuated, resulting in an outside pressure approaching 15 pounds per square inch, the ½ inch thick panes of Tuf-flex deflected ⅛ inch inwardly but held perfectly.

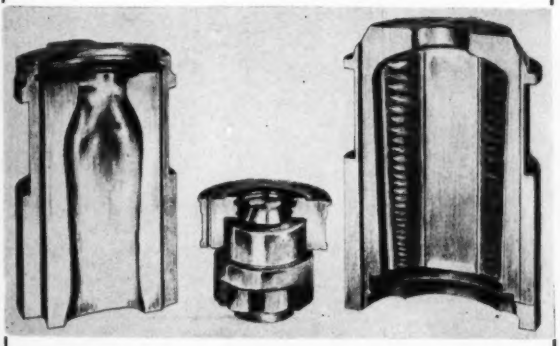
In another case, Tuf-flex plate glass is being used for lenses for eye glasses by the Unbreakable Lens Co. of America. The company, using plate glass, makes molds in which corrections are ground in and then shipped back to the Libbey-Owens-Ford Glass, where the molds are heat-strengthened.

This glass is also used for glazing portholes in battleships and other marine craft, and in color form for a new type of structural glass store front.

• Lighting elements in the highly Oriental Court of Flowers at the 1939 Golden Gate Exposition, San Francisco, will be modeled on Siamese ceremonial umbrellas with translucent tops of flexible woven glass. Elsewhere, glass illuminating tubes, their inside surface coated with chemicals that retain all light rays except the ultra-violet, will allow the use of "black light" on fluorescent paint.

• Latest news from the Corning Glass Works is Ivrene Petalware, a new glass composition, ivory in color with an iridescent undertone. It is moulded by an exclusive automatic process into service pieces as thin as fine china.

Engineering



• **Properly designed and accurate moulds are a very important factor in a glass factory in insuring good production. The wide range and length of experience our Engineers have had in designing moulds for the various machines has enabled our moulds to go into production with a minimum amount of expense and loss of time.**

THE TOLEDO MOULD COMPANY
1920 CLINTON STREET
Toledo, Ohio, U.S.A.

You naturally want the most economical as well as the most efficient solution . . . And that is where Ransome's 88 years of experience in mixing design and manufacture will prove of real benefit to you. Submit your problems today.

Industrial Division
Ransome Concrete Machinery Co.
Dunellen, N. J.

A RANSOME designed Mixer of 60 Cu.Ft. capacity used by a large manufacturer for the mixing of Enamel Frits.

CLEVELAND TRAMRAIL

MATERIALS HANDLING EQUIPMENT

Consult your phone directory under Cleveland Tramrail.

CLEVELAND TRAMRAIL

Division of

THE CLEVELAND CRANE & ENGINEERING CO.

1161 Depot St.

WICKLIFFE, OHIO

Non Segregation of Batch

- Glass men know this will improve quality and uniformity.
- A mixer load is handled in each separate container — in train lots— this is how Cleveland Tramrail Engineers, in conjunction with engineering departments of glass manufacturers, have adapted TRAMRAIL to solving of this problem.
- Other problems in the Glass Industry have been likewise solved.
- Motor or hand operated equipment to suit your capacity is available.

TWENTY-ONE YEARS

A Professor Looks out on the Glass Industry

By

Professor W. E. S. Turner, O.B.E., D.Sc., F.R.S.

Professor Turner's Presidential Address to the Society of Glass Technology in November, 1937 has been printed on special paper and issued in book form.

It has been hailed as a masterly review of all technical progress in the glass industry during the past generation. It should appeal to and be followed with interest by every person engaged in the industry.

Price $2.75. Post free.

Orders, with remittances, may be sent to the Society's American Treasurer, Mr. F.C. Flint, B.S., F.S.G.T., The Hazel-Atlas Glass Company, Zanesville, Ohio; or direct to the Society of Glass Technology, Darnall Road, Sheffield 9, England.

THE SHARP-SCHURTZ COMPANY

CHEMISTS AND CONSULTING ENGINEERS

FOR THE GLASS INDUSTRY

LANCASTER, OHIO U. S. A.

WT

BOTTLES

FULL AUTOMATIC MACHINE PROCESS

Whitall Tatum Company

Manufacturers Since 1836

Philadelphia New York

FACTORIES: MILLVILLE, N. J.